**VIVIAN GORDON HARSH APARTMENTS RENOVATION**

**4247 South Oakenwald Avenue**
**Chicago, IL 60653**

# Specifications

November 04, 2021

# Project Manual

## Issue for Bid and Permit

*prepared for:*
Chicago Housing Authority
60 East Van Buren Street
Chicago, IL 60603

*prepared by:*
Urban**Works**
125 South Clark Street,
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UrbanWorks

**SECTION 00 00 00**

**HOW TO USE THE CHA GUIDELINE SPECIFICATIONS**

The Chicago Housing Authority Guideline Specifications were prepared to aid Architects and/or Engineers of Record (A/E) engaged by the CHA on the specification of building, site, utility, infrastructure, and associated elements commonly employed in the renovation, rehabilitation, new construction, and additions to CHA facilities. The Guideline Specifications are based upon, and generally follow, the AIA MasterSpec format with CHA specific edits geared toward the specific performance and maintenance objectives of the Chicago Housing Authority. It is anticipated that these Guideline Specifications will be periodically updated by the CHA as products, processes, procedures, technology, codes, ordinances and CHA preferences warrant. It is further anticipated that updates will generally follow the format and content of AIA MasterSpec updates as they become available, with CHA specific edits and specification editor notes.

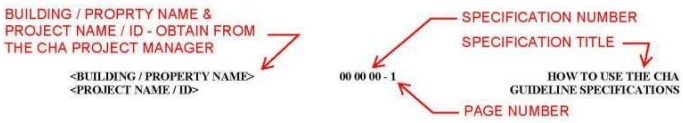
The menu of Guideline Specifications is not intended to include "any and all" sections that may be required for a particular project, nor does it include all options within a section that may be required. It is CHA's intent that these specifications be employed to the greatest extent as a starting point for commonly used products and systems required for work on the agency's buildings and properties. This document has been prepared to define the philosophy of the guideline specifications, and to attain parity on the way that they are employed by architects and engineers.

**Specification Header**
The Guideline Specification header includes both a CHA Control Revision ID/Date and a Project Revision ID/Date:


The CHA Control Revision ID/Date corresponds to the CHA's issuance version and date and shall not be altered by the A/E. This must be retained so that a particular project control source can be tracked for record purposes.

The Project Revision ID/Date corresponds to the A/E's issuance ID and Date for a given project. This ID is alphabetically sequential, with "A" corresponding to the first issuance of a particular specification and "B" corresponding to the second issuance, etc. Certain specifications may be issued earlier than other sections and should carry with them the appropriate alphabetic sequence letter, however, the Project Revision date should always correspond to the date of issuance, regardless of the alphabetic letter ID. The font for the header text shall be Times New Roman 9pt and be left justified.

**Specification Footer**
The Specification Footer includes the CHA Building / Property Name (left-justified), Project Name / ID (left justified beneath the Building/Project Name), numeric Specification Designation and page number (center-justified) and Specification Title (right justified). The font shall be Times New Roman 9pt bold. Text shall be in all caps.



**Body Text**
Specification body text should be Times New Roman 11pt and shall conform to MasterSpec formatting principles and standards.

**Specification Editor Notes**
Specification editor notes are indicated in blue, bold, italicized 11pt Times New Roman text within the individual specification sections for the convenience of the A/E in the review and editing of the specification sections and shall be removed prior to publication. The specifier notes call attention to certain key information. The Specification editor notes should not be construed to represent all necessary decisions and edits that may be required to be made to a particular specification for a particular purpose. The A/E is responsible for the appropriate selection and editing of sections for the specific project.

Sample specifier note:

***REVIEW SECTION 00 00 00 "HOW TO USE THE CHA GUIDELINE SPECIFICATIONS".***

**A/E Editor Responsibilities**
In addition to obligations outlined in the A/E contract for professional services, the following should be considered when working with the CHA Guideline Specifications:

1. The A/E of record is responsible to review and coordinate the contents of the Guideline Specifications with the project scope of work and edit for project specificity as appropriate. Sections shall be revised by deleting and inserting text to meet project specific requirements.
2. The A/E is responsible to review and confirm that named products are available and meet stated performance requirements.
3. The A/E is responsible for verifying the accuracy of titles and references and for ensuring that referenced sections are included in the project manual.
4. The A/E shall not add, delete, or modify any of the following provisions of the Guideline Specifications without prior written approval during design of the CHA's Project Manager and/or Designated Representative:

    - Listed manufacturers and/or products
    - Warranty requirements
    - Attic stock
    - Testing requirements
    - O&M requirements
    - As-Built drawings

5. Where a product or system is included in the published menu of CHA Guideline Specifications the CHA master shall be utilized and edited as appropriate. Where products and/or systems are required for a project for which no CHA Guideline Specification master exists the A/E shall independently author specification section(s). A/E authored specifications shall generally conform to the AIA MasterSpec format and shall exclude a CHA Control Revision in the header.
6. The A/E shall align all specification nomenclature to conform to the General and Supplementary Conditions of the contract. For example, references to the Owner shall be "the CHA" or "the CHA's Designated Representative", and terminology in the specifications shall be aligned accordingly.

**END OF SECTION**

# PROJECT MANUAL TABLE OF CONTENTS
# VIVIAN GORDON HARSH APARTMENTS RENOVATIONS
# ISSUE FOR BID & PERMIT

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**SECTION 01 10 00**

**SUMMARY**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. CHA-furnished products.
5. Access to site.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and Drawing conventions.
9. Miscellaneous provisions.

B. Related Requirements:

1. Section 01 50 00 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of the CHA's facilities.

1.3 PROJECT INFORMATION

A. Project Identification: Vivian Gordon Harsh Apartments Renovations / 12015/054AD.

1. Project Location: 4247 S Oakenwald Avenue Chicago, IL.

B. Owner: Chicago House Authority (CHA).

1. The CHA's Designated Representative: Robert Foster.

C. Architect: UrbanWorks Ltd. Contact: Patricia Saldaña Natke

1.4 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. The Work includes the addition to and renovation of an existing 14-story 108,000 s.f. multi-family residential building for senior housing. The building is of Type I-A construction and is comprised of a reinforced concrete structural frame supporting non-bearing face brick and CMU masonry walls.

2. Specific scope includes:
   a. improvements to the site, building envelope and MEP/FP/IT systems,
   b. the addition to and expansion of the Entry Vestibule and Lobby,
   c. improvements to building interiors
   d. the addition of Maintenance and Storage Area and new Electrical Room, and
   e. other Work indicated in the Contract Documents.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.5 ACCESS TO SITE

A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

B. Use of Site: Limit use of Project site to Work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Confine construction operations to areas necessary for the work.

2. Driveways, Walkways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to CHA, CHA's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

D. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

## 1.6 COORDINATION WITH OCCUPANTS

A. Full CHA Occupancy: The CHA will occupy site and existing building(s) during entire construction period. Cooperate with the CHA during construction operations to minimize conflicts and facilitate CHA usage. Perform the Work so as not to interfere with the CHA's day-to-day operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from CHA and approval of authorities having jurisdiction.
2. Notify the CHA not less than 72 hours in advance of activities that will affect CHA's operations.

## 1.7 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 8:00 a.m. to 4:00 p.m., Monday through Friday, unless otherwise indicated.

1. Early Morning Hours: Work limited to non-noisy activity in building systems support areas, can begin at 7:00 a.m.
2. Hours for Utility Shutdowns: Provide not less than 72 hours' notice to CHA of activities that will affect CHA's operations. Duration of shutdown limited to 4 hours at a time. Coordinate with CHA’s Designated Representative and occupants.
3. Hours for noisy activity: 8:00 a.m. to 4:00 p.m., Monday through Friday.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by the CHA or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify the CHA's Designated Representative not less than two days in advance of proposed utility interruptions.
2. Obtain the CHA's written permission before proceeding with utility interruptions.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to CHA occupancy with the CHA.

1. Notify the CHA's Designated Representative not less than two days in advance of proposed disruptive operations.
2. Obtain the CHA's written permission before proceeding with disruptive operations.

E. Restricted Substances: Use of tobacco products and other controlled substances within the existing building is not permitted.

F. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

G. Employee Screening: Comply with the CHA's requirements for drug and background screening of Contractor personnel working on Project site.

1. Maintain list of approved screened personnel with the CHA's Designated Representative.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 21 00**

**ALLOWANCES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.

B. Types of allowances include the following:

1. Lump-sum allowances.
2. Unit-cost allowances.
3. Quantity allowances.
4. Contingency allowances.
5. Testing and inspecting allowances.

C. Related Requirements:

1. Section 01 22 00 "Unit Prices" for procedures for using unit prices, including adjustment of quantity allowances when applicable.
2. Section 01 40 00 "Quality Requirements" for procedures governing the use of allowances for field testing by an independent testing agency.

### 1.3 DEFINITIONS

A. Allowance is a quantity of work or dollar amount established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

### 1.4 SELECTION AND PURCHASE

A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the CHA to avoid delaying the Work.

B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.

C. Purchase products and systems selected by Architect

1.5 ACTION SUBMITTALS

A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

1.6 INFORMATIONAL SUBMITTALS

A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.7 LUMP-SUM ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by the CHA or selected by Architect under allowance and shall include freight and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by the CHA or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to the CHA, after installation has been completed and accepted.

1.8 UNIT-COST ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by the CHA or selected by Architect under allowance and shall include freight and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by the CHA or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to the CHA, after installation has been completed and accepted.

1.9 QUANTITY ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by the CHA or selected by Architect under allowance and shall include freight and delivery to Project site.

B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by the CHA or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.

C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to the CHA, after installation has been completed and accepted.

1.10 CONTINGENCY ALLOWANCES

A. Use the contingency allowance only as directed by Architect for the CHA's purposes and only by Change Orders that indicate amounts to be charged to the allowance.

B. Contractor's related costs for products and equipment ordered by the CHA under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, insurance, equipment rental, and similar costs.

C. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit.

D. At Project closeout, credit unused amounts remaining in the contingency allowance to the CHA by Change Order.

1.11 TESTING AND INSPECTING ALLOWANCES

A. Testing and inspecting allowances include the cost of engaging testing agencies, actual tests and inspections, and reporting results.

B. The allowance does not include incidental labor required to assist the testing agency or costs for retesting if previous tests and inspections result in failure. The cost for incidental labor to assist the testing agency shall be included in the Contract Sum.

C. Costs of testing and inspection services not required by the Contract Documents are not included in the allowance.

D. At Project closeout, credit unused amounts remaining in the testing and inspecting allowance to the CHA by Change Order.

1.12 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement

of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.
2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.
3. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit-cost allowances.
4. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.

1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

A. Allowance No. 1: Lump Sum for Permit Fees and Permit Expediting Costs

1. If the amount noted is insufficient to cover actual permit fees and/or permit expediting costs, the General Contractor will be reimbursed for any additional expenditures through a contract modification.
2. Non-expended funds will be credited to the CHA in the form of a deductive contract modification after substantial completion.

B. Allowance No. 2: Lump Sum for Masonry and Roof Restoration

1. Strictly limited to all costs incurred by the General Contractor for masonry and roof issues discovered during the construction process or in excess of the base scope of work.
2. If the amount noted is insufficient to cover actual costs, the General Contractor will be reimbursed for any additional expenditure through a contract modification.
3. Non-expended funds will be credited to the CHA in the form of a deductive contract modification after substantial completion.

C. Allowance No. 3: Lump Sum for Environmental Conditions

1. Strictly limited to all costs incurred by the General Contractor for environmental conditions discovered during the construction process and required to be abated to complete base scope of work.
2. If the amount noted is insufficient to cover actual costs, the General Contractor will be reimbursed for any additional expenditure through a contract modification.
3. Non-expended funds will be credited to the CHA in the form of a deductive contract modification after substantial completion.

D. Allowance No. 4: Contingency Allowance for Change Orders

1. Strictly limited for potential Change Orders classified and justified as Discovered Conditions or Code Compliance changes.
2. If the amount noted is insufficient to cover actual costs, the General Contractor will be reimbursed for any additional expenditure through a contract modification.
3. Non-expended funds will be credited to the CHA in the form of a deductive contract modification after substantial completion.

**END OF SECTION**

**SECTION 01 22 00**

**UNIT PRICES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

B. Related Requirements:

1. Section 01 21 00 "Allowances" for procedures for using unit prices to adjust quantity allowances.
2. Section 01 26 00 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

A. Unit price is a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, overhead, and profit.

B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. The CHA reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at the CHA's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 SCHEDULE OF UNIT PRICES

A. Unit Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.

1. Description: Unsatisfactory soil excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, according to Section 31 22 14 "Earthwork."
2. Unit of Measurement: Cubic yard of soil excavated, based on in-place surveys of volume before and after removal.
3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 01 21 00 "Allowances."

B. Unit Price No. 2: Cutting and patching of concrete slabs-on-grade.

1. Description: Cutting of new or existing concrete slabs-on-grade up to 6 inches thick, removal and excavation as required, and subsequent backfill, compaction, and patching of concrete according to Section 01 73 00 "Execution." not otherwise indicated in the Contract Documents.
2. Unit of Measurement: Square feet of concrete removed.
3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 01 21 00 "Allowances."

**END OF SECTION**

**SECTION 01 25 00**

**SUBSTITUTION PROCEDURES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

### 1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions beyond Contractor's control.

a. Unavailability: The specified product or method of construction is no longer available.
b. Regulatory changes.

2. Substitutions for Convenience: Changes proposed by Contractor that may offer substantial advantage to the Project and to the CHA.

a. Substitution requests offering advantages solely to the Contractor will not be considered.

### 1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use facsimile of form provided in Section "01 25 00.01 Substitution Request Form".

2. Documentation: Show compliance with requirements for substitutions.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 GENERAL REQUIREMENTS

A. All Substitution Requests are to utilize the form 01 25 00.01 “Substitution Request Form”.

B. Refer to 01 60 00 “Product Requirements” for additional requirements for product selection and substitution limitations.

C. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
2. Agrees to provide the same warranty for the substitution as for the specified product.
3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to the CHA.
4. Waives claims for additional costs or time extension that may subsequently become apparent.

D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.

1. Note explicitly any non-compliant characteristics.

E. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.

1. Forms included in Section 00 25 01.01 “Substitution Request Form” are adequate for this purpose, and must be used.

2. Attach applicable supporting documentation. Provide point-by-point side-by-side comparison addressing essential attributes specified, as appropriate and relevant for the item.

F. Limit each request to a single proposed substitution item.

1. Submit an electronic document, combining the request form with supporting data into single document.

G. There shall be no time extensions granted due to time required for completion of the Substitution process either successfully or unsuccessfully.

## 3.2 SUBSTITUTION PROCEDURES

A. Submittal Form: Submit substitution requests by completing the form in Section 01 25 01.01 "Substitution Request Form". Use only this form; other forms of submission areunacceptable.

B. Submit request for Substitution for Cause within 14 days of discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.

C. Submit request for Substitution for Convenience immediately upon discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.

1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Project and the CHA through cost savings, time savings, greater energy conservation, or in other specific ways.
2. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.

D. The Architect shall consider requests for substitutions which are received within thirty (30) days after the Notice to Proceed. Any such requests which are received by the Architect more than thirty (30) days after the date of the Notice to Proceed may be considered or rejected in the sole and absolute discretion of the Architect.

## 3.3 RESOLUTION

A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner. Architect will request additional information or documentation for evaluation within one week of receipt of a request for substitution.

B. The architect shall perform the evaluation and send the recommendation for approval to CHA. CHA only can approve the substitution in writing.

C. Architect will notify Contractor in writing of decision to accept or reject request within 14 days of receipt of the request, or 7 days of receipt of additional information or documentation, whichever is later.

1. The CHA's decision following review of proposed substitution will be noted on the submitted form.
2. Use the product specified if the CHA cannot make a decision on the use of a proposed substitute within the time allocated.

**END OF SECTION**

**SECTION 01 25 00.01**

**SUBSTITUTION REQUEST FORM**

BUILDING/PROJECT: Vivian Gordon Harsh Apartments Renovations / 12015_054AD

TO: ARCHITECT: UrbanWorks Ltd.

CC: CHA'S DESIGNATED REPRESENTATIVE: Robert Foster

DATE SUBMITTED:

GENERAL CONTRACTOR:

SUBMITTING CONTRACTOR:
*(if different from GC)*

Address:

Contact Name:

Phone Number:

Email Address:

Referenced Specification Section: _____ Paragraph: _____

| REQUESTED SUBSTITUTION: | | In Lieu of Specified Manufacturer/Product: |
|---|---|---|
| Manufacturer Name | | |
| Product/Model | | |
| Manufacturer Address | | |
| Contact Name | | |
| Phone Number | | |

Reason For Substitution (select one of the following):

☐ The specified product or method of construction is no longer available.

☐ Additional benefits (in cost, time, or performance) are available to the Project and to the CHA with the requested substitute product.

Additional Explanation:_____

_____

_____

Attach applicable supporting documentation including, but not limited to, the following (select all that are included with this request):

☐ Itemized Comparison of the requested substitution with product specified. REQUIRED

☐ Performance and Test Data, including performance against specified reference standards. REQUIRED

☐ Manufacturer's Qualifications: Evidence of manufacturer qualifications and reputation for prompt delivery and efficiency in servicing products. REQUIRED

☐ Previous Installations: Attach list of not less than 5 similar projects on which proposed substitution was used. List projects in the Chicago area. List name and address of project, date of installation, and name, address, and phone number of Architect. REQUIRED

☐ Color Chart, illustrating Manufacturer’s full range. IF APPLICABLE

☐ Installation Instructions. IF APPLICABLE

☐ Maintenance Instructions. IF APPLICABLE

☐ Changes in Work: Attach data relating to changes required in other work to permit use of proposed substitution and changes required in construction schedule. IF APPLICABLE

☐ Cost Data: Attach accurate cost data on proposed substitution in comparison with product specified. IF APPLICABLE

In making this request for substitution, the Submitting Contractor and General Contractor represents that:

a. Contractor has examined the Contract Documents and investigated the proposed product/system and has determined that the proposed substitution is appropriate for the use intended for this Project, and shall meet or exceed the quality level of the specified product/system.
b. Contractor shall provide the same warranties for the substituted product/system as required for the product/system specified.
c. Contractor shall coordinate installation of accepted substitution into Work, and make changes to other Work that may be required for the Work to be complete with no additional cost to the Board.
d. Contractor waives all claims for additional costs related to accepted substitutions that may subsequently become apparent.
e. Cost data is complete and includes all related costs for this Project.

*Submitting Company Name:*

*Authorized Signature:* _____

*Printed Name:* _____ *Date:* _____

REVIEWED BY INSTALLER: (company name): _____

*Signature:* _____ *Date:* _____

REVIEWED BY MANUFACTURER: (company name): _____

*Signature:* _____ *Date:* _____

REVIEWED BY GENERAL CONTRACTOR: (company name): _____

*Signature:* _____ *Date:* _____

Requests that are not complete will be returned by the AOR for additional information.

Requests that do not meet CHA requirements for acceptable substitutions will be rejected.

AOR REVIEW: The submitted information has been reviewed by the Architect and found to be complete and meets the CHA requirements for acceptable substitution

*Agreement By (Name):* _____

*AOR Firm Name:*_____ *Date:*_____

CHA REVIEW:

Substitution Accepted by CHA:_____Date:_____Submit substituted product for review

Substitution Rejected by CHA:_____Date:_____Submit specified product for review

**SECTION 01 26 00**

**CONTRACT MODIFICATION PROCEDURES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Section 01 25 00 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

A. Architect will issue through the CHA's Project Management Software supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710.

1.4 PROPOSAL REQUESTS

A. CHA-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
c. Include costs of labor and supervision directly attributable to the change.

d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
e. Quotation Form: Use forms provided by the CHA.

B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to the CHA's Designated Representative and Architect.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use the same format as CHA-Initiated Proposal Requests.

## 1.5 ADMINISTRATIVE CHANGE ORDERS

A. Allowance Adjustment: See Section 012100 "Allowances" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.

B. Unit-Price Adjustment: See Section 012200 "Unit Prices" for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect measured scope of unit-price work.

## 1.6 CHANGE ORDER PROCEDURES

A. On the CHA's approval of a Work Change Proposal Request, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

## 1.7 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 29 00**

**PAYMENT PROCEDURES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
2. Section 01 33 00 “Submittal Procedures” for administrative requirements governing the preparation and submittal of the submittal schedule.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:

a. Application for Payment forms with continuation sheets.
b. Submittal schedule.
c. Items required to be indicated as separate activities in Contractor’s construction schedule.

2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

3. Subschedules for Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the schedule of values:

    a. Project name and location.
    b. Name of Architect.
    c. Architect's Project number.
    d. Contractor's name and address.
    e. Date of submittal.

2. Arrange schedule of values consistent with format of AIA Document G703.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
4. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

    a. Differentiate between items stored on-site and items stored off-site.

5. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
6. Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items, including but not limited to:

    a. Required Bonds and insurance.
    b. Permit fees.
    c. Mobilization.
    d. Temporary facilities and controls.
    e. Testing of materials or equipment.
    f. Closeout documentation, including Record Documents.

7. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
8. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by the CHA.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between the CHA and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

1. Submit draft copy of Application for Payment seven days prior to due date for review by Architect.

C. Application for Payment Forms: Use HUD Payment Form 5370-27, AIA Document G702, and forms provided by the CHA.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. The CHA will return incomplete applications without action.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
4. Indicate separate amounts for work being carried out under CHA-requested project acceleration.

E. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to the CHA, and consent of surety to payment for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

F. Transmittal: Submit three signed and notarized original copies of each Application for Payment to the Architect by a method ensuring receipt. Each copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

G. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. The CHA reserves the right to designate which entities involved in the Work must submit waivers.
4. Waiver Forms: Submit executed waivers of lien on forms provided by the CHA.

H. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. Schedule of unit prices.
6. Submittal schedule (preliminary if not final).
7. List of Contractor's staff assignments.
8. List of Contractor's principal consultants.
9. Copies of building permits.
10. Initial progress report.
11. Report of preconstruction conference.

I. Application for Payment at Substantial Completion: After Architect issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. Evidence that claims have been settled.

5. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
6. Final liquidated damages settlement statement.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 31 00**

**PROJECT MANAGEMENT AND COORDINATION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. RFIs.
4. Digital project management procedures.
5. Project meetings.

B. Related Requirements:

1. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
2. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.
3. Section 01 91 13 "General Commissioning Requirements" for coordinating the Work with the Commissioning Authority.

### 1.3 DEFINITIONS

A. RFI: Request for Information. Request from the CHA, Architect, or Contractor seeking information required by or clarifications of the Contract Documents.

### 1.4 INFORMATIONAL SUBMITTALS

A. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, and in prominent location in built facility. Keep list current at all times.

## 1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
f. Indicate required installation sequences.
g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
3. Mechanical and Plumbing Work: Show the following:
4. Review: Architect will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Submittal Format: Submit or post coordination drawing files using PDF format.
2. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.

a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
b. Digital Data Software Program: Drawings are available in Revit for Windows.
c. Contractor shall execute a data licensing agreement in the form of Agreement form acceptable to the CHA and Architect.

1.7 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: AIA Document G716 or Software-generated form with substantially the same content as indicated above, acceptable to Architect.

1. Attachments shall be electronic files in PDF format.

D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow **seven** <**7**> working days for Architect's response for each RFI. RFIs received by Architect after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents.
    e. Requests for adjustments in the Contract Time or the Contract Sum.
    f. Requests for interpretation of Architect's actions on submittals.
    g. Incomplete RFIs or inaccurately prepared RFIs.

2. If, in the opinion of the Architect, additional time is required to review existing field conditions or to confer with consultants, the Architect shall notify the Contractor in writing, copying the CHA's Designated Representative. Additional time to facilitate a coordinated response shall not constitute a delay of the Work nor shall it be the basis for an extension of time.
3. Architect's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log with not less than the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Architect.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Architect's response was received.
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

## 1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Web-Based Project Software: Use the CHA's web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.

## 1.9 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify the CHA's Designated Representative and Architect of scheduled meeting dates and times a minimum of 10 working days prior to meeting.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including the CHA's Designated Representative and Architect, within three days of the meeting.

B. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise the CHA's Designated Representative and the Architect of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

a. Contract Documents.

b. Options.
c. Related RFIs.
d. Related Change Orders.
e. Purchases.
f. Deliveries.
g. Submittals.
h. Review of mockups.
i. Possible conflicts.
j. Compatibility requirements.
k. Time schedules.
l. Weather limitations.
m. Manufacturer's written instructions.
n. Warranty requirements.
o. Compatibility of materials.
p. Acceptability of substrates.
q. Temporary facilities and controls.
r. Space and access limitations.
s. Regulations of authorities having jurisdiction.
t. Testing and inspecting requirements.
u. Installation procedures.
v. Coordination with other work.
w. Required performance results.
x. Protection of adjacent work.
y. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

C. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to the CHA's Designated Representative and Architect, but no later than 60 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of the CHA, **the Commissioning Authority,** Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of Record Documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.

c. Procedures for completing and archiving web-based Project software site data files.
d. Submittal of written warranties.
e. Requirements for preparing operations and maintenance data.
f. Requirements for delivery of material samples, attic stock, and spare parts.
g. Requirements for demonstration and training.
h. Preparation of Contractor's punch list.
i. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
j. Submittal procedures.
k. The CHA's partial occupancy requirements.
l. Installation of CHA's furniture, fixtures, and equipment.
m. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

D. Progress Meetings: Conduct progress meetings at weekly intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of the CHA**, the Commissioning Authority** and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site use.
8) Temporary facilities and controls.
9) Progress cleaning.
10) Quality and work standards.
11) Status of correction of deficient items.
12) Field observations.

13) Status of RFIs.
14) Status of Proposal Requests.
15) Pending changes.
16) Status of Change Orders.
17) Pending claims and disputes.
18) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 32 00**

**CONSTRUCTION PROGRESS DOCUMENTATION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Daily construction reports.
2. Site condition reports.
3. Unusual event reports.

### 1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. PDF file.

B. Daily Construction Reports: Submit at **monthly** intervals.

C. Site Condition Reports: Submit at time of discovery of differing conditions.

### 1.4 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Testing and inspection.
8. Accidents.
9. Meetings and significant decisions.
10. Unusual events.

11. Stoppages, delays, shortages, and losses.
12. Meter readings and similar recordings.
13. Emergency procedures.
14. Orders and requests of authorities having jurisdiction.
15. Change Orders received and implemented.
16. Construction Change Directives received and implemented.
17. Services connected and disconnected.
18. Equipment or system tests and startups.
19. Partial completions and occupancies.
20. Substantial Completions authorized.

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

C. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.

1. Submit unusual event reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 32 33**

**PHOTOGRAPHIC DOCUMENTATION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Periodic construction photographs.
3. Final completion construction photographs.

B. Related Requirements:

1. Section 01 77 00 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project closeout.
2. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of the CHA's personnel.
3. Section 02 41 19 "Selective Demolition" for photographic documentation before selective demolition operations commence.
4. Section 31 10 00 "Site Clearing" for photographic documentation before site clearing operations commence.

### 1.3 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit image files within three days of taking photographs.

1. Identification: Provide the following information with each image description in file metadata tag:

a. Name of Project.
b. Name and contact information for photographer.
c. Name of Architect.
d. Name of Contractor.
e. Date photograph was taken.
f. Description of location, vantage point, and direction.

g. Unique sequential identifier keyed to accompanying key plan.
h. Weather conditions at time of photograph.

1.4 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 3200 by 2400 pixels. Use flash in low light levels or backlit conditions.

1. Provide file in PDF format as well, should original not be compatible such as NEF.

B. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

C. Metadata: Record accurate date and time from camera.

D. File Names: Name media files with date and sequential numbering suffix.

1.5 CONSTRUCTION PHOTOGRAPHS

A. General: Take photographs with maximum depth of field and in focus.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

B. Preconstruction Photographs: Before commencement of excavation, demolition, and start of construction, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.

1. Flag excavation areas and construction limits before taking construction photographs.
2. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
3. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

C. Construction Photographs: Take 20 photographs weekly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

D. Architect Directed Construction Photographs: In addition to the general progress photographs, take photographs during each of the following construction phases:

1. Subgrade construction.
2. Above-grade structural framing.
3. Exterior building enclosure: take photos of the installation of each of the following components:

a. Flashing

b. Lintels/shelf angles
c. Windows
d. Masonry
e. Roofing

4. Interior utility work.
5. The Architect will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.

E. Final Completion Construction Photographs: Take photographs after date of Substantial Completion for submission as Project Record Documents. Architect will inform photographer of desired vantage points.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 33 00**

**SUBMITTAL PROCEDURES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:

1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
2. Section 01 31 00 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
3. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
4. Section 01 32 33 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and final completion construction photographs.
5. Section 01 40 00 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
6. Section 01 77 00 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
7. Section 01 78 23 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
8. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
9. Section 01 79 00 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of the CHA's personnel.

### 1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

## 1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal Category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Architect's final release or approval.

## 1.5 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Architect.
4. Name of Contractor.
5. Name of firm or entity that prepared submittal.
6. Names of subcontractor, manufacturer, and supplier.
7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
8. Category and type of submittal.
9. Submittal purpose and description.

10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

E. Submittals for Web-Based Project Software: Prepare submittals as PDF files, or other format indicated by Project software website.

## 1.6 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the

Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 10 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 7 days for review of each resubmittal.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

## 1.7 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

    a. Wiring diagrams that show factory-installed wiring.
    b. Printed performance curves.
    c. Operational range diagrams.

d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

a. Project name and submittal number.
b. Generic description of Sample.
c. Product name and name of manufacturer.
d. Sample source.
e. Number and title of applicable Specification Section.
f. Specification paragraph number and generic name of each item.

3. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
b. Samples not incorporated into the Work, or otherwise designated as CHA's property, are the property of Contractor.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

   a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned.

      1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
      2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

    a. Name of evaluation organization.
    b. Date of evaluation.
    c. Time period when report is in effect.
    d. Product and manufacturers' names.
    e. Description of product.
    f. Test procedures and results.
    g. Limitations of use.

## 1.8 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.9 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp and as indicated in web-based Project software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 ARCHITECT'S REVIEW

A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required.

**1.** PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action**.**

a. Actions taken by indication on Response forms have the following meanings:

1) “No Exceptions” means no changes are necessary on the reviewed Submittal. The Contractor may proceed with the Work for that Submittal. Re-submittal is not required.
2) “Exceptions as Noted” indicates that the Submittal is accepted subject to the corrections and/or comments noted. The Contractor may proceed with the Work for that Submittal if the Contractor incorporates the Architect’s comments, and/or corrections. Re-submittal is not required.
3) “Revise and Resubmit” means that the Submittal does not meet all the requirements necessary to proceed with the Work associated with the Submittal. The Contractor must resubmit in accordance with the reviewer’s comments and/or corrections. Submittal marked in this manner must not be released for fabrication, delivery, or construction.

4) "Rejected" means the submittal does not meet the requirements set out in the Contract Documents. The Contractor must resubmit in accordance with the Contract Documents and any corrections and/or comments made regarding the Submittal by the reviewer. Submittals marked in this manner shall not be released for fabrication, delivery, or construction.
5) "Retain for Records" means the submittals are being retained for informational purposes only or were submitted to comply with an administrative requirement of the contract.

2. Submittals by Web-Based Project Software: Architect will indicate, on Project software website, the appropriate action.

B. Informational Submittals: Architect will review each submittal and will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Architect will discard submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Architect without action.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 35 16**

**ALTERATION PROJECT PROCEDURES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes special procedures for alteration work.

1.3 DEFINITIONS

A. Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.

B. Consolidate: To strengthen loose or deteriorated materials in place.

C. Design Reference Sample: A sample that represents the Architect's prebid selection of work to be matched; it may be existing work or work specially produced for the Project.

D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Architect.

F. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.

G. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.

H. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.

I. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.

J. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.

K. Retain: To keep existing items that are not to be removed or dismantled.

L. Strip: To remove existing finish down to base material unless otherwise indicated.

1.4 COORDINATION

A. Alteration Work Subschedule: A construction schedule coordinating the sequencing and scheduling of alteration work for entire Project, including each activity to be performed, and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for alteration work.

1. Schedule construction operations in sequence required to obtain best Work results.
2. Coordinate sequence of alteration work activities to accommodate the following:

    a. CHA's continuing occupancy of portions of existing building.
    b. CHA's partial occupancy of completed Work.
    c. Other known work in progress.
    d. Tests and inspections.

3. Detail sequence of alteration work, with start and end dates.
4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
5. Use of elevator and stairs.
6. Equipment Data: List gross loaded weight, axle-load distribution, and wheel-base dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.

1.5 PROJECT MEETINGS FOR ALTERATION WORK

A. Preliminary Conference for Alteration Work: Before starting alteration work, conduct conference at Project site.

1. Attendees: In addition to representatives of the CHA, Architect, and Contractor, testing service representative, specialists, and chemical-cleaner manufacturer(s) shall be represented at the meeting.
2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:

    a. Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
    b. Fire-prevention plan.
    c. Governing regulations.
    d. Areas where existing construction is to remain and the required protection.
    e. Hauling routes.
    f. Sequence of alteration work operations.
    g. Storage, protection, and accounting for salvaged and specially fabricated items.

h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
i. Qualifications of personnel assigned to alteration work and assigned duties.
j. Requirements for extent and quality of work, tolerances, and required clearances.
k. Embedded work such as flashings and lintels, special details, collection of waste, protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.

3. Reporting: Record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.

## 1.6 MATERIALS OWNERSHIP

A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to CHA that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain CHA's property.

1. Carefully dismantle and salvage each item or object in a manner to prevent damage and protect it from damage, then promptly deliver it to CHA where directed.

## 1.7 INFORMATIONAL SUBMITTALS

A. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements that are to remain, including finish surfaces, that might be misconstrued as damage caused by Contractor's alteration work operations.

B. Alteration Work Program: Submit 30 days before work begins.

C. Fire-Prevention Plan: Submit 30 days before work begins.

## 1.8 QUALITY ASSURANCE

A. Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections.

1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress. Dust control must comply with Section 01 56 11 “General Dust, Fume, and Odor Control”.
2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers. Debris hauling must comply with section 01 74 19 “Construction Waste Management and Disposal”, Section 31 23 18.13 “Subtitle D Waste Disposal” or Section 31 23 18.14 “Clean Construction or Demolition Debris and Uncontaminated Soil Disposal,” as applicable.

B. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with the CHA's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.

C. Safety and Health Standard: Comply with ANSI/ASSE A10.6.

1.9 STORAGE AND HANDLING OF SALVAGED MATERIALS

A. Salvaged Materials:

1. Clean loose dirt and debris from salvaged items unless more extensive cleaning is indicated.
2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
3. Store items in a secure area until delivery to CHA.
4. Transport items to the CHA's storage area designated by CHA.
5. Protect items from damage during transport and storage.

B. Salvaged Materials for Reinstallation:

1. Repair and clean items for reuse as indicated.
2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.

C. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by Architect, items may be dismantled and taken to a suitable, protected storage location during construction work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.

D. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.

1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
2. Secure stored materials to protect from theft.
3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 deg F or more above the dew point.

E. Storage Space:
1. Arrange for off-site locations for storage and protection of salvaged material that cannot be stored and protected on-site.

1.10 FIELD CONDITIONS

A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of preconstruction photographs.

1. Comply with requirements specified in Section 01 32 33 "Photographic Documentation."

B. Discrepancies: Notify Architect of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.

C. The CHA's Removals: Before beginning alteration work, verify in correspondence with the CHA that the following items have been removed:

1. As noted in the Construction Documents.

**PART 2 - PRODUCTS - (Not Used)**

**PART 3 - EXECUTION**

3.1 PROTECTION

A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.

1. Use only proven protection methods, appropriate to each area and surface being protected.
2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
3. Erect temporary barriers to form and maintain fire-egress routes.
4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces. Dust control must comply with Section 01 56 11 “General Dust, Fume, and Odor Control.”
6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.

B. Temporary Protection of Materials to Remain:

1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.

C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.

D. Utility and Communications Services:

1. Notify the CHA, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.

E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.

1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from alteration work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

F. Existing Roofing: Prior to the start of work in an area, install roofing protection.

## 3.2 PROTECTION FROM FIRE

A. General: Follow fire-prevention plan and the following:

1. Comply with NFPA 241 requirements unless otherwise indicated.
2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.

    a. If combustible material cannot be removed, provide fire blankets to cover such materials.
    b. Combustible material shall be removed from Project site in accordance with Section 01 74 19 “Construction Waste Management and Disposal” or Section 02 86 13 “Hazardous and Universal Waste Management,” as applicable.

B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:

1. Use of open-flame equipment is not permitted.
2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.

4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:

    a. Train each fire watch in the proper operation of fire-control equipment and alarms.
    b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
    c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
    d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work in each area to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.

C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.

D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.

1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is complete.

## 3.3 PROTECTION DURING APPLICATION OF CHEMICALS

A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.

B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.

C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.

D. Neutralize alkaline and acid wastes and legally dispose of off CHA's property.

E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

F. Chemical application and disposal must comply with Section 01 56 11 “General Dust, Fume and Odor Control,” and Section 31 23 18.15 “Special, Non-Hazardous Special, and Hazardous Waste Soil Removal and Disposal,” as applicable.

3.4 GENERAL ALTERATION WORK

A. Have specialty work performed only by qualified specialists.

B. Ensure that supervisory personnel are present when work begins and during its progress.

C. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs. Comply with requirements in Section 01 32 33 "Photographic Documentation."

D. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.

E. Notify Architect of visible changes in the integrity of material or components whether from environmental causes including UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.

1. Do not proceed with the work in question until directed by Architect.

**END OF SECTION**

**SECTION 01 40 00**

**QUALITY REQUIREMENTS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, the CHA, or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

C. Related Requirements:

1. Section 01 21 00 "Allowances" for testing and inspection allowances.

### 1.3 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements or as part of permanent construction, consisting of multiple products, assemblies, and subassemblies.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

## 1.4 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Shop Drawings: For integrated exterior mockups.

1. Include plans, sections, and elevations, indicating materials and size of mockup construction.
2. Indicate manufacturer and model number of individual components.
3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

B. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

D. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.

3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

E. Reports: Prepare and submit certified written reports and documents as specified.

F. Permits, Licenses, and Certificates: For CHA's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

## 1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager may also serve as Project superintendent.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
3. CHA-performed tests and inspections indicated in the Contract Documents.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.

4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

   a. Provide test specimens representative of proposed products and construction.
   b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
   c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
   d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups of masonry repairs at the end floor building.
2. Build mockups in location indicated or, if not indicated, as directed by Architect.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.
6. Obtain Architect's approval of mockups before starting corresponding work, fabrication, or construction.

   a. Allow seven days for initial review and each re-review of each mockup.

7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed unless otherwise indicated.
9. Complete masonry repairs on mockups at completion of contract

L. Integrated Exterior Mockups: Construct integrated exterior mockup **as indicated on Drawings**. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials. Comply with requirements in "Mockups" Paragraph.

## 1.11 QUALITY CONTROL

A. CHA Responsibilities: Where quality-control services are indicated as CHA's responsibility, the CHA will engage a qualified testing agency to perform these services.

1. Payment for these services will be made from testing and inspection allowances, as authorized by Change Orders.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to the CHA are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.

    a. Contractor shall not employ same entity engaged by the CHA, unless agreed to in writing by the CHA.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including

service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.

1. Distribution: Distribute schedule to the CHA's Designated Representative, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

## 1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:

1. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
2. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.

3. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
4. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
5. Retesting and reinspecting corrected work.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's and the CHA's Designated Representative's reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

**END OF SECTION**

**SECTION 01 42 00**

**REFERENCES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

### 1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if

bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

## 1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. ABMA - American Boiler Manufacturers Association; www.abma.com.
4. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org
5. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
6. AGA - American Gas Association; www.aga.org.
7. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
8. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
9. AI - Asphalt Institute; www.asphaltinstitute.org.
10. AIA - American Institute of Architects (The); www.aia.org.
11. AISC - American Institute of Steel Construction; www.aisc.org.
12. AISI - American Iron and Steel Institute; www.steel.org.
13. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
14. ANSI - American National Standards Institute; www.ansi.org.
15. APA - APA - The Engineered Wood Association; www.apawood.org.
16. APA - Architectural Precast Association; www.archprecast.org.
17. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
18. ASCE - American Society of Civil Engineers; www.asce.org.
19. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
20. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
21. ASSE - American Society of Safety Engineers (The); www.asse.org.
22. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
23. ASTM - ASTM International; www.astm.org.
24. AWI - Architectural Woodwork Institute; www.awinet.org.
25. AWPA - American Wood Protection Association; www.awpa.com.
26. AWS - American Welding Society; www.aws.org.
27. AWWA - American Water Works Association; www.awwa.org.
28. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.

29. BIA - Brick Industry Association (The); www.gobrick.com.
30. CEA - Consumer Electronics Association; www.ce.org.
31. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
32. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
33. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
34. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
35. CPA - Composite Panel Association; www.pbmdf.com.
36. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
37. CRRC - Cool Roof Rating Council; www.coolroofs.org.
38. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
39. CSI - Construction Specifications Institute (The); www.csinet.org.
40. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
41. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
42. DHI - Door and Hardware Institute; www.dhi.org.
43. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
44. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org .
45. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
46. FM Approvals - FM Approvals LLC; www.fmglobal.com.
47. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
48. FSC - Forest Stewardship Council U.S.; www.fscus.org.
49. GA - Gypsum Association; www.gypsum.org.
50. GANA - Glass Association of North America; www.glasswebsite.com.
51. GS - Green Seal; www.greenseal.org.
52. HI - Hydraulic Institute; www.pumps.org.
53. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
54. ICC - International Code Council; www.iccsafe.org.
55. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
56. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
57. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
58. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
59. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
60. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
61. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
62. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
63. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
64. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
65. ISO - International Organization for Standardization; www.iso.org.
66. LMA - Laminating Materials Association; (See CPA).
67. LPI - Lightning Protection Institute; www.lightning.org.
68. MCA - Metal Construction Association; www.metalconstruction.org.
69. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
70. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
71. MIA - Marble Institute of America; www.marble-institute.com.
72. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
73. MPI - Master Painters Institute; www.paintinfo.com.
74. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.

75. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
76. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
77. NADCA - National Air Duct Cleaners Association; www.nadca.com.
78. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
79. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
80. NBI - New Buildings Institute; www.newbuildings.org.
81. NCMA - National Concrete Masonry Association; www.ncma.org.
82. NEBB - National Environmental Balancing Bureau; www.nebb.org.
83. NECA - National Electrical Contractors Association; www.necanet.org.
84. NEMA - National Electrical Manufacturers Association; www.nema.org.
85. NETA - InterNational Electrical Testing Association; www.netaworld.org.
86. NFPA - National Fire Protection Association; www.nfpa.org.
87. NFRC - National Fenestration Rating Council; www.nfrc.org.
88. NHLA - National Hardwood Lumber Association; www.nhla.com.
89. NLGA - National Lumber Grades Authority; www.nlga.org.
90. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
91. NRCA - National Roofing Contractors Association; www.nrca.net.
92. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
93. NSF - NSF International; www.nsf.org.
94. NSPE - National Society of Professional Engineers; www.nspe.org.
95. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
96. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
97. NWFA - National Wood Flooring Association; www.nwfa.org.
98. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
99. PDI - Plumbing & Drainage Institute; www.pdionline.org.
100. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
101. RFCI - Resilient Floor Covering Institute; www.rfci.com.
102. SDI - Steel Deck Institute; www.sdi.org.
103. SDI - Steel Door Institute; www.steeldoor.org.
104. SIA - Security Industry Association; www.siaonline.org.
105. SJI - Steel Joist Institute; www.steeljoist.org.
106. SMA - Screen Manufacturers Association; www.smainfo.org.
107. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
108. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
109. SPRI - Single Ply Roofing Industry; www.spri.org.
110. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
111. SSINA - Specialty Steel Industry of North America; www.ssina.com.
112. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
113. STI - Steel Tank Institute; www.steeltank.com.
114. SWI - Steel Window Institute; www.steelwindows.com.
115. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
116. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
117. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
118. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
119. TMS - The Masonry Society; www.masonrysociety.org.
120. TPI - Truss Plate Institute; www.tpinst.org.

121. TRI - Tile Roofing Institute; www.tileroofing.org.
122. UL - Underwriters Laboratories Inc.; http://www.ul.com.
123. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
124. USGBC - U.S. Green Building Council; www.usgbc.org.
125. WASTEC - Waste Equipment Technology Association; www.wastec.org.
126. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
127. WDMA - Window & Door Manufacturers Association; www.wdma.com.
128. WI - Woodwork Institute; www.wicnet.org.

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
2. ICC - International Code Council; www.iccsafe.org.
3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
2. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
3. DOE - Department of Energy; www.energy.gov.
4. EPA - Environmental Protection Agency; www.epa.gov.
5. FAA - Federal Aviation Administration; www.faa.gov.
6. FG - Federal Government Publications; www.gpo.gov/fdsys.
7. GSA - General Services Administration; www.gsa.gov.
8. HUD - Department of Housing and Urban Development; www.hud.gov.
9. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
10. OSHA - Occupational Safety & Health Administration; www.osha.gov.
11. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
12. USPS - United States Postal Service; www.usps.com.

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
2. FED-STD - Federal Standard; (See FS).
3. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.

    a. Available from General Services Administration; www.gsa.gov.

b. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org/ccb.

4. USAB - United States Access Board; www.access-board.gov.
5. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 50 00**

**TEMPORARY FACILITIES AND CONTROLS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

### 1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Architect, occupants, testing agencies, and authorities having jurisdiction.

B. Electric Power Service: The CHA will pay electric-power-service use charges for electricity used by all entities for construction operations.

C. Water and Sewer Service from Existing System: Water from CHA's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

D. Electric Power Service from Existing System: Electric power from CHA's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

### 1.4 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

D. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Dust control must comply with Section 01 56 11 “General Dust, Fume, and Odor Control”. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in UFAS Section 504 and ICC/ANSI A117.1.

1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before the CHA's acceptance, regardless of previously assigned responsibilities.

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil (0.25-mm) minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.

B. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches (914 by 1524 mm).

C. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Common-Use Field Office: Of sufficient size to accommodate needs of the CHA, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.
3. Drinking water and private toilet.
4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
5. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.

C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

**PART 3 - EXECUTION**

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as the CHA's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 01 10 00 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, the CHA, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Connect to CHA's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to the CHA. At Substantial Completion, restore these facilities to condition existing before initial use.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

D. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

E. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas. Dust control must comply with Section 01 56 11 “General Dust, Fume, and Odor Control.”

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.

a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.

2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

F. Electric Power Service: Connect to CHA's existing electric power service. Maintain equipment in a condition acceptable to the CHA.

G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

H. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment and one land-based telephone line for each field office.

1. At each telephone, post a list of important telephone numbers.

a. Police and fire departments.
b. Ambulance service.
c. Contractor's home office.
d. Contractor's emergency after-hours telephone number.
e. Architect's office.
f. Engineers' offices.
g. The CHA's office.
h. Principal subcontractors' field and home offices.

I. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Architect and the CHA's Designated Representative to access Project electronic documents and maintain electronic communications. Equip computer with not less than the following:

1. Processor: Intel Core i5 or i7.
2. Memory: 4 gigabyte.
3. Disk Storage: 500 gigabyte hard-disk drive and combination DVD-RW/CD-RW drive.
4. Display: 24-inch (610-mm) LCD monitor with 256-Mb dedicated video RAM.
5. Full-size keyboard and mouse.
6. Network Connectivity: Gigabit.
7. Operating System: Microsoft Windows 7 Professional.
8. Productivity Software:

a. Microsoft Office Professional, 2010 or higher, including Word, Excel, and Outlook.
b. Adobe Reader 11.0 or higher.
c. WinZip 7.0 or higher.

9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.

10. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 1.0 Mbps upload and 15 Mbps download speeds at each computer.
11. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
12. Backup: External hard drive, minimum 2 terrabyte, with automated backup software providing daily backups.

## 3.4 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Maintain support facilities until Architect schedules Substantial Completion inspection. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the CHA.

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

C. Parking: Construction Personnel shall not use the tenant parking lot

D. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rain water in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.

2. Remove snow and ice as required to minimize accumulations.

E. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touch up signs so they are legible at all times.

F. Waste Disposal Facilities: Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal,", Section 31 23 18.13 “Subtitle D Waste Disposal”, or Section 31 23 18.14 “Clean Construction or Demolition Debris and Uncontaminated Soil”, as applicable.

G. (Reserved)

H. Temporary Elevator Use:
1. The use of the existing building elevators to transport personnel or any use related with the construction scope will be limited and will have to be approved by the building management prior to use.

I. Existing Stair Usage: Use of CHA's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to the CHA. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

## 3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 01 10 00 "Summary."

C. Tree and Plant Protection: Comply with requirements specified in Section 01 56 39 "Temporary Tree and Plant Protection."

D. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

E. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

F. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

G. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by tenants from fumes and dust. Dust control must comply with Section 01 56 11 “General Dust, Fume and Odor Control,”

1. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.

3. Protect air-handling equipment.
4. Provide walk-off mats at each entrance through temporary partition.

H. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

## 3.6 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. The CHA reserves right to take possession of Project identification signs.
2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00 "Closeout Procedures."

**END OF SECTION**

**SECTION 01 56 11**

**GENERAL DUST, FUME AND ODOR CONTROL**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Dust and fume emission control is required to maintain a healthful environment for residents, maintain good public relations with neighbors and employees, prevent damage, minimize cleaning and maintenance costs, and to comply with regulations and laws. All Contractors (including subcontractors, lower-tier subcontractors, and suppliers) who perform work or provide services for the Chicago Housing Authority (CHA) are required to control dust and fume emissions from their operations and/or activities. This includes the disturbance of painted components or materials.

### 1.3 DEFINITIONS

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in this Section are incorporated by reference, whether or not restated herein.

B. Architect of Record (AOR) means the entity that assembles the overall documents and bid package, and approves the completed work.

C. Chicago Housing Authority (CHA) means the owner of the property and the authority ordering the work specified herein.

D. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

E. Contractor means the entity responsible for performing the complete scope of work in the Documents. The Contractor may elect to self-perform or subcontract out any portion of the work.

F. HEPA Filter means a High Efficiency Particulate Air filter capable of trapping 99.97% percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.

G. IDPH means the Illinois Department of Public Health.

H. Environmental Consultant (EC) designs the environmental work, maintains the documents, conducts oversight, and reviews the environmental work, submittals, and reports.

I. Plasticize means to apply plastic sheeting over surfaces or objects to protect them from contamination or water damage.

J. Personal Protective Equipment (PPE) means the protective suits, head and foot covers, gloves, respirators and other items used to protect persons from potential hazards.

K. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

L. Work Area means the area or areas where work is being conducted.

1.4 WORK INCLUDED

A. The work includes the control of all nuisance or noxious dust, vapors, fumes, odors or emissions caused by construction, demolition, renovation, restoration, or related activities including, but not limited to sawing, cutting, grinding, sanding, abrading, sweeping, crushing, scraping, gluing, prying, plowing, heating, finishing, painting welding, torch cutting or burning, or any other related processes at CHA facilities that can create noxious dust, fumes or odors.

B. No visible emissions or unreasonable odors will be permitted outside the work area.

C. All products to be used that will possibly cause emissions shall be accompanied with SDS sheets to be submitted to the AOR and/or CHA's Designated Representative prior to the use of the product.

1.5 LAWS, REGULATIONS, AND STANDARDS.

A. The Contractor is responsible for compliance with all applicable federal, state, county and municipal laws, regulations and ordinances including, but not limited to, those listed below, which are incorporated by reference.

B. The following laws, regulations and standards are incorporated by reference:

1. 29 CFR 1910: US OSHA General Industry Standards
2. 29 CFR 1926: US OSHA Construction Standards
3. 40 CFR Part 61: USEPA National Emissions Standards for Hazardous Air Pollutants (NESHAP)
4. 11-4-2170: Chicago Building Code- Demolition and renovation safeguards
5. 11-4-2190: Chicago Building Code: Sandblasting, grinding and chemical washing of buildings, facilities or other structures - Dust minimization – Containment, wetting or vacuuming; plan required
6. 40 CFR 745: Lead Renovation, Repair and Painting Program

C. Contractor shall follow procedures outlined in this specification for all work which requires the disturbance of painted surfaces regardless of whether the paint is designated as containing lead greater than 1.0 mg/cm2 as defined by XRF or 0.5% by weight as defined by laboratory analysis. If contract work requires disturbance of more than 3 linear or 3 square feet of lead

based paint, Contractor shall perform work in accordance with Specification Section 028319.13.

1.6 SUBMITTALS

A. Dust- And HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Plan must be approved by EC prior to Work. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste handling procedures.
5. Other dust-control measures proposed by the Contractor.

1.7 NOTIFICATION

A. The Contractor shall provide notification to the CHA's Designated Representative and EC no less than forty-eight (48) business hours prior to placing barricades, lockdown, or traffic barriers.

**PART 2 - PRODUCTS – NOT USED**

**PART 3 - EXECUTION**

3.1 BARRIERS OR WORK AREA ISOLATION

A. Contractor shall prevent the spread of dust, fumes and odors from their immediate work areas by:

1. Erecting dust-tight barriers between indoor work areas and adjacent occupied areas. Construction barriers may be used for this purpose if suitably constructed to prevent dust and fume migration.
2. Closing and/or covering windows, intake vents, louvers, or other building openings in the immediate vicinity of outdoor work, sufficient to prevent dust, fume or odor migration into the building interior. If such openings cannot be adequately sealed by closing, then poly sheeting, tape, or other impermeable covers shall be used.
3. The Contractor shall provide a HEPA filtered, local exhaust system for the isolated work area(s).
4. Where applicable the Contractor shall move all furnishings and equipment out of the area of work. Place plastic drop cloths over and under fixed-in-place equipment or furnishings to remain in room or work area. Lap and seal covering so that dust and debris cannot become lodged on these items or fall into them.
5. Place plastic drop cloth on floor in room or area of work. Extend plastic ten (10) feet from all areas of work on painted surfaces or materials including any area where paint debris may be thrown by Contractor's activity. Lap and seal additional drop cloths to

make a complete floor area containment. Turn plastic up baseboard of walls within the work area and seal to wall with tape

B. Contractor is prohibited from creating other hazardous or uncomfortable conditions for building occupants, such as very hot, humid, cold, or other conditions created by ventilation system alterations or blockages, closed or open windows in hot or cold weather conditions.

C. Contractor is responsible for making itself familiar with building conditions and shall take care to isolate its work area in such a manner that building occupant activities and comfort are not unreasonably disrupted.

D. Where painted surfaces are disturbed, Contractor shall secure the work area by means of scheduling, locking, or use of traffic barriers. Overlapped polyethylene "flap" doorways should be installed at the entrance to the work area or room. Only Contractor personnel should be allowed in the work area. Contractor shall implement procedures and/or controls to ensure that workers and equipment leaving work area are clean to keep dust and debris within the work area.

## 3.2 DUST, FUME AND ODOR CONTROL

A. Dust, fume or odor release shall be prevented by a suitable means, including but not limited to:

1. Tools equipped with shrouds, HEPA filter equipped vacuum pickups
2. Alteration, shut down, or isolation of building ventilation systems in the immediate work vicinity
3. Shrouding around work activities
4. Shrouding stages, scaffolds, or other work platforms
5. Local exhaust ventilation systems exhausted to the outside of the building
6. HEPA vacuuming surfaces periodically during work activity
7. Wet work methods, except where poses additional hazards such as on or near electrical systems, For painted surface disturbances, Include misting area with a cleaning solution during debris collection, sanding, paint scraping, and penetrating (such as cutting, sawing, routing, planning, drilling, or nailing) activities. Collect debris with a wet cloth or HEPA vacuum.

B. The Contractor shall clean the work area after completing the work involving painted surfaces including:

1. Pick up debris with wet cloths and place in 6 mil bags or wrap in plastic for transport and disposal.
2. HEPA vacuum the work area, plastic, and disposable gloves, coveralls and shoe covers to remove visible dust and debris. Place disposable materials, including entrance flap cloths and drop cloths, in a disposal bag. Wipe dust off all tools and equipment.
3. Wet wipe the entire work area with a clean cloth and cleaning solution. Discard all used cleaning cloths in the disposal bag. Then wipe the entire work area with a clean cloth and clean water until clean.

C. It is the Contractor’s responsibility to select the means and methods it considers most suitable to achieve dust, fume and odor control.

D. In the event that dust or fumes escape from the work area or create dirty conditions or contamination to nearby building spaces or grounds, the Contractor is responsible for all costs associated with the cleaning, testing and/ or repair deemed necessary by the CHA's Designated Representative.

**END OF SECTION**

**SECTION 01 56 39**

**TEMPORARY TREE AND PLANT PROTECTION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

B. Related Requirements:

1. Section 01 50 00 "Temporary Facilities and Controls" for temporary site fencing.
2. Section 31 10 00 "Site Clearing" for removing existing trees and shrubs.

### 1.3 DEFINITIONS

A. Caliper: Diameter of a trunk measured by a diameter tape at a height 6 inches (150 mm) above the ground for trees up to and including 4-inch (100-mm) size at this height and as measured at a height of 12 inches (300 mm) above the ground for trees larger than 4-inch (100-mm) size.

B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape at a height 54 inches (1372 mm) above the ground line for trees with caliper of 8 inches (200 mm) or greater as measured at a height of 12 inches (300 mm) above the ground.

C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings and defined by a circle concentric with each tree with a radius 12 times the tree's caliper size and with a minimum radius of 96 inches (2400 mm) unless otherwise indicated.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

    a. Tree-service firm's personnel, and equipment needed to make progress and avoid delays.
    b. Arborist's responsibilities.
    c. Quality-control program.
    d. Coordination of Work and equipment movement with the locations of protection zones.
    e. Trenching by hand or with air spade within protection zones.
    f. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.
2. Detail fabrication and assembly of protection-zone fencing and signage.
3. Indicate extent of trenching by hand or with air spade within protection zones.

C. Samples: For each type of the following:

1. Protection-Zone Fencing: 4” Assembled Samples made from full-size components.
2. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

D. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Arborist and tree service firm.

B. Certification: From Arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From Arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality-control program.

1.7 QUALITY ASSURANCE

A. Arborist Qualifications: Arborist as Certified by ISA or Licensed arborist in jurisdiction where Project is located.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified Arborist to Project site during execution of the Work.

C. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work without damaging trees and plantings. Include dimensioned diagrams for placement of protection zone fencing and signage, the Arborist's and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

1.8 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Moving or parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements:

1. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50-mm) maximum opening in pattern and weighing a minimum of 0.4 lb/ft. (0.6 kg/m); remaining flexible from minus 60 to plus 200 deg F (minus 16 to plus 93 deg C); inert to most chemicals and acids; minimum tensile yield strength of 2000 psi (13.8 MPa) and ultimate tensile strength of 2680 psi (18.5 MPa); secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 96 inches (2400 mm) apart.

    a. Height: 48 inches (1200 mm).
    b. Color: High-visibility orange, nonfading.

2. Gates: Single or Double swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 36 inches (914 mm).

B. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: As shown on Drawings.
2. Lettering: 3-inch- (75-mm-) high minimum, black characters on white background.

## PART 3 - EXECUTION

### 3.1 TREE AND LANDSCAPE PROTECTION – GENERAL

A. The Contractor and Arborist is required to meet with the CHA's Designated Representative at the site prior to beginning work to review all work procedures, access and haul routes, and tree and landscape protection measures.

B. The Arborist and CHA's Designated Representative shall be on site during all operations within protection zones. 24-hour notice must be given to CHA's Designated Representative requesting their presence for work scheduled within the tree protection zone.

C. Any damage to trees due to the Contractor's activities shall be reported to the CHA's Designated Representative within 6 hours so that proper remedial action can be taken.

### 3.2 STAGING AND WORK ACTIVITIES – GENERAL

A. No grade changes, including cutting (soil removal) or filling (deposition of soil) will be allowed within tree protection zones or on the root zones of trees.

B. Demolition, removal, repair, construction or other work on structures or underground features within protection zones shall be accomplished using the smallest equipment possible, operated from outside the protection zone.

C. Temporary vehicle clearance:

1. Where temporary clearance is needed for access, tree branches shall be tied back to hold them clear of the clearance zone. Tie backs shall be done in such a manner as to prevent any cracking or breakage of branches or skinning of bark.
2. All tree pruning required for clearance during construction must be approved by the Arborist and the CHA's Designated Representative. All pruning is to be performed by the Arborist.

D. Chemical Treatments:

1. Any use of herbicides or pesticides shall be in compliance with the Integrated Pest Management Plan for the property.
2. All herbicides, insecticides, pesticides or other chemicals proposed for use on the project site must be safe for use around trees, not easily transported by water, labeled for the use intended and approved for use by the Arborist and the CHA's Designated Representative.
3. All chemicals used on the project site must be used and disposed of according to the labeled directions.

E. Spoil from trenches, basement, or other excavations shall not be placed within tree protection zones, either temporarily or permanently.

F. No burn piles or debris pits shall be placed within tree protection zones. No ashes, debris, or garbage may be dumped or buried within the tree protection zone.

## 3.3 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. Prepare written report, endorsed by the Arborist, listing conditions detrimental to tree and plant protection.

## 3.4 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Tie a 1-inch (25-mm) blue vinyl tape around each tree trunk at 54 inches (1372 mm) above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

## 3.5 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections

where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
2. Access Gates: Install where indicated; adjust to operate smoothly, easily, and quietly; free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
3. Tree and landscape protection fencing is to be maintained intact by the Contractor throughout the duration of the work and until all site work has been completed. Removal or relocation of protection fencing must be approved by the Arborist and the CHA's Designated Representative.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect. Install one sign spaced approximately every 50 feet (15 m) on protection-zone fencing, but no fewer than four signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by the Arborist if a root buffer effective against soil compaction is constructed as directed by the Arborist. Maintain root buffer so long as access is permitted.

E. Driving, parking, dumping, stockpiling and/or storage of vehicles, equipment, supplies, materials, debris, spoils, waste or washout water within tree and/or landscape protection zones is strictly prohibited.

F. All underground utilities, drain and/or irrigation lines are to be routed outside the landscape protection zone. If underground lines must traverse the protection area, they shall be tunneled or bored below the root zones.

## 3.6 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 312214 "Earthwork" and Section 312323 "Acceptance of Backfill, Topsoil, and CU structural Soil" unless otherwise indicated.

B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.

C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.

D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

## 3.7 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as follows:

1. Before grading, excavation or trenching for project work, manually dig a 24" deep trench one (1) foot outside the tree protection zone perimeter.
2. As roots are exposed, cleanly cut with a hand saw, vibrating knife, rock saw, narrow trencher with sharp blades, or other root-pruning equipment approved by the Arborist. Do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Section 31 20 00 "Earth Moving."
6. Any roots damaged during grading or construction shall be exposed to sound tissue and cut cleanly with a saw.

B. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

## 3.8 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches as shown on Drawings, under direction of the Arborist.

1. Prune to remove only injured, broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.
3. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and as indicated on Drawings.

B. Unless otherwise directed by the Arborist and acceptable to Architect, do not cut tree leaders.

C. Cut branches with sharp pruning instruments; do not break or chop.

D. Do not paint or apply sealants to wounds.

E. Provide subsequent maintenance pruning during Contract period as recommended by the Arborist.

F. Chip removed branches and dispose of off-site.

3.9 BRUSH CLEARING AND REMOVAL

A. Any brush clearing required within the tree protection zone shall be accomplished with hand-operated equipment.

B. Removal of all downed brush within protection areas shall occur by lifting the material out either by hand or with equipment staged outside the tree protection zone. Dragging or skidding across the ground will not be permitted.

3.10 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by the Arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is 2 inches (50 mm) or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.11 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.12 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Architect.

1. Submit details of proposed pruning and repairs.

2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to the Arborist's written instructions.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace dead and damaged trees that the Arborist determines to be incapable of restoring to a normal growth pattern.

1. Provide new trees of the same size and species as those being replaced for trees measuring less than 6 inches in caliper size.

2. If tree required to be replaced is more than 6 inches in caliper size, measured 12 inches above grade, provide new tree of 6-inch caliper size and of a species selected by Architect.

3. Trees shall be cut near ground level and the stump ground out to a clear depth of eighteen inches below grade, or as otherwise specified.

4. Trees to be removed from project areas not within tree protection zones must be felled and removed in such a way as to avoid damage to tree(s) and understory to remain.
   a. Tree(s) to be removed which have branches extending into the canopy of tree(s) to remain must be removed in a manner that causes no damage to the branches, limbs, trunk or bark of tree(s) and understory to remain.
   b. Trees to be removed shall be felled so as to fall away from tree protection zones and to avoid pulling and breaking of roots of trees to remain. If roots are entwined, confirm with the Arborist if first severing the major woody root mass is required before extracting the trees. This may be accomplished by cutting through the roots by hand, with a vibrating knife, rock saw, narrow trencher with sharp blades, or other root-pruning equipment as approved by the Arborist.
   c. Extraction of downed trees within protection areas shall occur by lifting the material out either by hand or with equipment staged outside the tree protection zone. Dragging or skidding across the ground will not be permitted.

5. Plant and maintain new trees as specified in Section 329300 "Plants."

C. Soil Aeration: Where directed by the Arborist, aerate surface soil compacted during construction. Aerate 10 feet (3 m) beyond drip line and no closer than 36 inches (900 mm) to tree trunk. Drill 2-inch- (50-mm-) diameter holes a minimum of 12 inches (300 mm) deep at 24 inches (600 mm) o.c. Backfill holes with an equal mix of augered soil and sand.

## 3.13 CLEANING

A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off the CHA's property.

B. All soils, fill, and topsoil requiring removal from the site shall be handled in accordance with Section 31 23 18.13 "Soil, Fill, Backfill, General Construction and Demolition Debris Disposal" or Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," as applicable.

C. Burning is not permitted.

D. Remove all temporary fencing.

E. Remove all cushioning material installed for “access routes”. Material must be removed either by hand or with small bobcat-type machines. All of the material must be removed. Where small machinery is used to remove the bulk of the material, removal of material in contact with the soil surface must be done by hand, and in such a way as to minimize disturbance of the soil surface and prevent damage to surface or feeder roots.

F. Upon completion of work, the Contractor is responsible for ensuring that all landscaped areas within the scope of work, including adjacent areas that may have been impacted, are clean and free of trash or debris.

G. All existing landscaped areas are to be restored to their previous condition.

**END OF SECTION**

**SECTION 01 60 00**

**PRODUCT REQUIREMENTS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. Section 01 25 00 "Substitution Procedures" for requests for substitutions.
2. Section 01 42 00 "References" for applicable industry standards for products specified.

### 1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved by Architect through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications. Submit a comparable product request, if applicable.

## 1.4 ACTION SUBMITTALS

A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

    a. Form of Architect's Approval of Submittal: As specified in Section 01 33 00 "Submittal Procedures."
    b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Submittal Procedures." Show compliance with requirements.

## 1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

    a. Name of product and manufacturer.

b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment. Coordinate location with the CHA.

## 1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to the CHA.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for the CHA.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

**PART 2 - PRODUCTS**

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. The CHA reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

a. Submit additional documentation required by Architect in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Architect, whose determination is final.

B. Product Selection Procedures:

1. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: …"

2. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: …"

3. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

a. For approval of products by unnamed manufacturers, comply with requirements in Section 01 25 00 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 01 25 00 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:

1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
2. Evidence that proposed product provides specified warranty.

3. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
4. Samples, if requested.

B. Submittal Requirements: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 73 00**

**EXECUTION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.

B. Related Requirements:

1. Section 01 10 00 "Summary" for limits on use of Project site.
2. Section 01 33 00 "Submittal Procedures" for submitting surveys.
3. Section 01 77 00 "Closeout Procedures" for replacing defective work, and final cleaning.
4. Section 02 41 19 "Selective Demolition" for demolition and removal of selected portions of the building.
5. Section 07 84 13 "Penetration Firestopping" for patching penetrations in fire-rated construction.

### 1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

### 1.4 PREINSTALLATION MEETINGS

A. Cutting and Patching Conference: Conduct conference at Project site.

1. Prior to commencing work requiring cutting and patching, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching work. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:

    a. Contractor's superintendent.
    b. Trade supervisor responsible for cutting operations.
    c. Trade supervisor(s) responsible for patching of each type of substrate.
    d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affecting by cutting and patching operations.

2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Certificates: Submit certificate signed by professional engineer certifying that location and elevation of improvements comply with requirements.

## 1.6 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements. For requirements regarding handling and disposal of hazardous materials including lead and asbestos, see Section 02 82 13 “Asbestos Abatement – Prior to Demolition,” Section 02 82 16 “Small Scale Drilling, Coring, and/or Anchoring Disturbances Less Than 3 Square or Linear Feet of Asbestos Containing Materials,” Section 02 83 20 "Minor Disturbance of Painted Surfaces Assumed to Contain Lead,” and Section 02 86 13 “Hazardous and Universal Waste Management.”

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operational elements include the following:

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

    a. Water, moisture, or vapor barriers.
    b. Membranes and flashings.
    c. Equipment supports.

d. Piping, ductwork, vessels, and equipment.
e. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other concealed utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, concealed mechanical and electrical systems, and other construction affecting the Work.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where

indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

## 3.2 PREPARATION

A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 01 31 00 "Project Management and Coordination."

## 3.3 FIELD ENGINEERING

## 3.4 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Repair or remove and replace damaged, defective, or nonconforming Work.

1. Comply with Section 01 77 00 "Closeout Procedures" for repairing or removing and replacing defective Work.

## 3.5 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay. For requirements regarding handling and disposal of hazardous materials including lead and asbestos, see Section 02 82 13 “Asbestos Abatement – Prior to Demolition,” Section 02 82 16 “Small Scale Drilling, Coring, and/or Anchoring Disturbances Less Than 3 Square or Linear Feet of Asbestos Containing Materials,” Section 02 83 20 "Minor Disturbance of Painted Surfaces Assumed to Contain Lead,” and Section 02 86 13 “Hazardous and Universal Waste Management.”

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Temporary Support: Provide temporary support of work to be cut.

C. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

D. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 01 10 00 "Summary."

E. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

F. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.

G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
b. Restore damaged pipe covering to its original condition.

3. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

H. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

## 3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully in accordance with Section 01 74 19 “Construction Waste Management and Disposal”, Section 31 23 18.13 “Subtitle D Waste Disposal”, or Section 31 23 18.14 “Clean Construction or Demolition Debris and Uncontaminated Soil Disposal”, as applicable.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations. Dispose of hazardous materials in accordance with Section 02 86 13 “Hazardous and Universal Waste Management.”

    a. Use containers intended for holding waste materials of type to be stored.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

## 3.7 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 01 91 13 "General Commissioning Requirements."

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

**END OF SECTION**

**SECTION 01 74 19**

**CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 04 20 00 "Unit Masonry" for disposal requirements for masonry waste.

### 1.3 DEFINITIONS

A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.

C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on CHA's property.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

1.5 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

D. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

E. Qualification Data: For waste management coordinator.

F. Refrigerant Recovery: Comply with requirements in Section 02 41 19 "Selective Demolition" for refrigerant recovery submittals.

1.7 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of

projects with similar requirements. Superintendent may serve as Waste Management Coordinator.

B. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.

C. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of each contractor and waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with Section 02 41 19 "Selective Demolition."
2. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
3. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
4. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

## PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of [**50**] [**75**] <**Insert number**> percent by weight of total nonhazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. When necessary, dispose and/or recycle hazardous materials in accordance with Section 02 86 13 "Hazardous and Universal Waste Management." Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:

a. Brick.
b. Concrete masonry units.
c. Roofing.
d. Insulation.
aa. Mechanical equipment.
cc. Electrical conduit.
dd. Copper wiring.

2. Construction Waste:

    a. Masonry and CMU.
    b. Roofing.
    c. Insulation.
    d. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

        1) Paper.
        2) Cardboard.
        3) Boxes.
        4) Plastic sheet and film.
        5) Polystyrene packaging.
        6) Wood crates.
        7) Wood pallets.
        8) Plastic pails.

    e. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:

        1) Paper.
        2) Aluminum cans.
        3) Glass containers.

## PART 3 - EXECUTION

### 3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 01 50 00 "Temporary Facilities and Controls."

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within **three** days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
2. Comply with Section 01 50 00 "Temporary Facilities and Controls" for controlling dust and dirt, and environmental protection.

## 3.2 SALVAGING DEMOLITION WASTE

A. Comply with requirements in Section 02 41 19 "Selective Demolition" for salvaging demolition waste.

## 3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Waste may be co-mingled at the site and separated at a recycling facility.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

    a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from CHA's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

A. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Clean and stack undamaged, whole masonry units on wood pallets.

B. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

C. Metals: Separate metals by type.

1. Remove and dispose of bolts, nuts, washers, and other rough hardware.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

D. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction and in accordance with Section 31 23 18.13 “Subtitle D Waste Disposal.”

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

**END OF SECTION**

**SECTION 01 77 00**

**CLOSEOUT PROCEDURES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Section 01 32 33 "Photographic Documentation" for submitting final completion construction photographic documentation.
2. Section 01 78 23 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
3. Section 01 78 39 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
4. Section 01 79 00 "Demonstration and Training" for requirements to train the CHA's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

### 1.3 ACTION SUBMITTALS

A. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

B. Certified List of Incomplete Items: Final submittal at final completion.

### 1.4 CLOSEOUT SUBMITTALS

A. Field Report: For pest control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases permitting CHA unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain the CHA's Designated Representative’s signature for receipt of submittals.

5. Submit testing, adjusting, and balancing records.
6. Submit changeover information related to the CHA's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Complete startup and testing of systems and equipment.
2. Perform preventive maintenance on equipment used prior to Substantial Completion.
3. Instruct the CHA's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 01 79 00 "Demonstration and Training."
4. Advise CHA of changeover in utility services.

5. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
6. Complete final cleaning requirements.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

## 1.7 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 01 29 00 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit final completion photographic documentation.
5. **Submit pest-control final inspection report.**

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

## 1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Architect.
    d. Name of Contractor.
    e. Page number.

1.9 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit the CHA's rights under warranty.

B. Partial Occupancy

C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

    1. Submit by uploading to web-based project software site.

E. Warranties in Paper Form:

    1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
    2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
    3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

F. Provide additional copies of each warranty to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

## PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Remove tools, construction equipment, machinery, and surplus material from Project site.
c. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
d. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

e. Remove labels that are not permanent.
f. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
g. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.

1) Clean HVAC system in compliance with NADCA ACR. Provide written report on completion of cleaning.

C. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

## 3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

**END OF SECTION**

**SECTION 01 78 23**

**OPERATION AND MAINTENANCE DATA**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory manuals.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

B. Related Requirements:

1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

2. Section 01 91 13 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.

### 1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

### 1.4 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Architect will comment on whether content of operation and maintenance submittals is acceptable.

2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.

C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.

1. Correct or revise each manual to comply with Architect's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.

E. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

## 1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

## 1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of the CHA.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Architect.
7. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
8. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

## 1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:

1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

## 1.8 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by CHA's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.

8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of CHA's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by CHA's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.

7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by CHA's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component

incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.11 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 78 39**

**PROJECT RECORD DOCUMENTS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:

1. Section 01 77 00 "Closeout Procedures" for general closeout procedures.
2. Section 01 78 23 "Operation and Maintenance Data" for operation and maintenance manual requirements.

### 1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one set(s) of marked-up record prints.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

E. Reports: Submit written report weekly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order or Construction Change Directive.
k. Changes made following Architect's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.
n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Annotated PDF electronic file.
2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
3. Refer instances of uncertainty to Architect for resolution.
4. Architect will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.

    a. See Section 01 31 00 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
    b. Architect will provide data file layer information. Record markups in separate layers.

C. Newly Prepared Record Drawings: Prepare new drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.

1. Newly Prepared Record Drawings may be required when a Change Order or Construction Change Directive is issued as a result of accepting an alternate, substitution, or other modification.
2. Consult Architect and the CHA's Designated Representative for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate Newly Prepared Record Drawings into Record Drawing sets; comply with Record Drawing procedures for formatting, organizing, copying, binding, and submitting.

D. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
2. Identification: As follows:

    a. Project name.
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Architect.
    e. Name of Contractor.

## 1.5 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file.

## 1.6 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

C. Format: Submit record Product Data as annotated PDF electronic file.

1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

## 1.7 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

## 1.8 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

**PART 2 - PRODUCTS**

**PART 3 - EXECUTION**

**END OF SECTION**

**SECTION 01 79 00**

**DEMONSTRATION AND TRAINING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. Demonstration and training video recordings.

B. (Reserved)

C. Unit Price for Instruction Time: Length of instruction time will be measured by actual time spent performing demonstration and training in required location. No payment will be made for time spent assembling educational materials, setting up, or cleaning up. See requirements in Section 012200 "Unit Prices."

1.3 INFORMATIONAL SUBMITTALS

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. Demonstration and training video recordings.

B. (Reserved)

C. Unit Price for Instruction Time: Length of instruction time will be measured by actual time spent performing demonstration and training in required location. No payment will be made for time spent assembling educational materials, setting up, or cleaning up. See requirements in Section 012200 "Unit Prices."

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two (2) copies within seven (7) days of end of each training module.
1. Identification: On each copy, provide an applied label with the following information:

a. Name of Project.
b. Name and address of videographer.
c. Name of Architect.
d. Name of Construction Manager.
e. Name of Contractor.
f. Date of video recording.

1. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
2. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
3. At completion of training, submit complete training manual(s) for Owner's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

## 1.5 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.

D. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

## 1.6 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Architect.

1.7 INSTRUCTIONAL PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

   a. System, subsystem, and equipment descriptions.
   b. Performance and design criteria if Contractor is delegated design responsibility.
   c. Operating standards.
   d. Regulatory requirements.
   e. Equipment function.
   f. Operating characteristics.
   g. Limiting conditions.
   h. Performance curves.

2. Documentation: Review the following items in detail:

   a. Emergency manuals.
   b. Systems and equipment operation manuals.
   c. Systems and equipment maintenance manuals.
   d. Product maintenance manuals.
   e. Project Record Documents.
   f. Identification systems.
   g. Warranties and bonds.
   h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Equipment or system break-in procedures.
c. Routine and normal operating instructions.
d. Regulation and control procedures.
e. Control sequences.
f. Safety procedures.
g. Instructions on stopping.
h. Normal shutdown instructions.
i. Operating procedures for emergencies.
j. Operating procedures for system, subsystem, or equipment failure.
k. Seasonal and weekend operating instructions.
l. Required sequences for electric or electronic systems.
m. Special operating instructions and procedures.

5. Adjustments: Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning.
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

1.8 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.9 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Architect will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. Owner will furnish an instructor to describe Owner's operational philosophy.
3. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner through Construction Manager with at least seven (7) days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral or a written or a demonstration performance-based test.

F. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.10 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. Testing General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode with vibration reduction technology.

1. Submit video recordings on CD-ROM or thumb drive.
2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.

3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:

    a. Name of Contractor/Installer.
    b. Business address.
    c. Business phone number.
    d. Point of contact.
    e. Email address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

1. Film training session(s) in segments not to exceed 15 minutes.

    a. Produce segments to present a single significant piece of equipment per segment.
    b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

1. Furnish additional portable lighting as required.

E. Narration: Describe scenes on video recording by either audio narration by microphone while video recording is recorded or by dubbing audio narration off-site afterwards. Include description of items being viewed.

F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 02 19 10**

**MOLD REMEDIATION**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings

1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. These specifications apply for all demolition, construction and renovation projects that require the remediation of mold-impacted materials in accordance with all applicable regulations.

1.3 INTRODUCTION

A. Mold remediation work that occurs in interior building spaces is not currently directly regulated by State of Illinois or Federal authorities. However, the work under this plan will generally follow "Mold Remediation in Schools and Commercial Buildings" guidelines as published by the United States Environmental Protection Agency (USEPA) and other state of the industry publications and peer-reviewed guidelines such as the New York City Department of Health "Guidelines on Assessment and Remediation of Fungi in Indoor Environments" (2000), Institute of Inspection Cleaning and Restoration Certification Standard and Reference Guide for Professional Mold Remediation (II CRC S520 – December 2003), and Bioaerosols Assessment and Control, 1999, published by the American Conference of Governmental Industrial Hygienists. The Contractor shall perform this work in accordance with all applicable regulations including, but not limited to the Illinois Environmental Protection Agency (IEPA), United States Environmental Protection Agency (USEPA), United States Department of Transportation (USDOT), Illinois Department of Labor, and United States Department of Labor (USDOL) Occupational Safety and Health Administration (OSHA).

1.4 WORK INCLUDED

A. The work includes all labor, equipment, materials and supplies necessary to perform mold remediation by the procedures described herein. The Contractor represents itself as knowledgeable and expert in the performance of the work, and includes all things usually and customarily necessary to provide a complete and finished job, whether specifically mentioned or not.

B. This work includes removal of mold-impacted materials or presumed mold-impacted materials and cleaning of mold-contaminated or presumed mold-contaminated materials including pre-cleaning, moving furnishings, establishing controlled areas, isolating the work areas, protection

of adjacent areas, containment, cleanup and decontamination to the specified clearance levels, proper packaging and disposal of waste or debris and all other steps necessary to complete the Scope of Work.

C. Contractor will comply with all applicable laws, regulations, standards and these specifications. In the case of a conflict, the Contractor will comply with the most stringent.

1.5 LAWS, REGULATIONS AND STANDARDS

The following laws, regulations and standards are incorporated by reference:

A. 29 CFR 1910.134 - OSHA Respiratory Protection Standard

B. 29 CFR 1910.1200 - OSHA Hazard Communication Standard

1.6 EMPLOYEE TRAINING, QUALIFICATIONS AND MEDICAL SCREENING

A. Supervisors and Workers shall be trained in the hazards of mold contamination under OSHA's Hazard Communication standard (29 CFR 1910.1200) and familiar with mold remediation practices. Workers shall be trained in the use and limitations of respirators in accordance with OSHA's Respiratory Protection Standard (29 CFR 1910.134) and in the use of any additional protective clothing in accordance with OSHA's Protective Equipment standard (29 CFR 1910.132 and 20 CFR 1910.133).

B. Medical Screening: All Contractor personnel shall have physical exams and respirator fit testing results documented and maintained on-site.

1.7 PERSONAL PROTECTIVE EQUIPMENT (PPE)

A. Respiratory Protection: Respiratory protection shall be worn by all persons in controlled areas who are actually or potentially exposed to airborne fungal spores.

1. Respiratory protection will include half-facepiece or full-facepiece National Institute for Occupational Safety and Health (NIOSH) approved respirators with filters designed for protection against P100 aerosols. The Contractor shall provide additional filter protection as needed for other gases, vapors, mists or fumes as appropriate, for example, in conjunction with the use of biocides. The filters shall be replaced as frequently as required by 29 CFR 1910.134.
2. Contractor shall have a written respiratory protection program in accordance with OSHA 29 CFR 1910.134 including but not limited to, medical screening, semi-annual fit testing, training, cleaning and maintenance.
3. Respiratory protection shall not be removed while in the controlled area.
4. The Contractor shall provide authorized visitors with suitable respirators and applicable personal protective clothing.

B. Protective Eyewear: Chemical splash goggles shall be provided there is a potential for spills or splashes of liquids or contact with mists and full-facepiece respirators are not worn.

C. Protective Work Clothing: Protective work clothing shall include impermeable coveralls (Tyvek or equivalent), impermeable foot covers, and work gloves. Workers shall double suit with Tyvek or equivalent if HEPA vacuum decontamination is performed (see 3.4.C). Single suits are permitted if workers shower before exiting the regulated work area. Chemical-resistant gloves shall be provided when biocides or other chemicals are used that may contact the hands. Contractor shall provide protective work clothing (Tyvek or equivalent), foot covering, work gloves and chemical gloves to the designated representative(s).

## 1.8 HYGIENE PRACTICES

A. Eating, drinking, smoking, chewing gum or tobacco, and applying of cosmetics are not allowed in the work area.

B. All persons entering the work area are required to wear appropriate PPE and follow the entry and exit procedures posted in the Personnel Decontamination Enclosure System.

C. All persons entering the contaminated work area are required to decontaminate using the three (3) chamber decontamination unit. Decontamination shall be performed by HEPA vacuuming the exterior double layer of the Tyvek suit before removal. Showering is optional. Decontamination unit shall be attached to the work area.

## 1.9 WORK AREA ISOLATION AND PREPARATION

A. General Preparation: Contractor shall

1. Notify the CHA that access to the work area is prohibited.
2. Secure the work area from entry by occupants or unauthorized personnel by providing physical barriers and/or lockable doors.
3. Separate Work Areas from Occupied Areas

    i. Seal off all doorways and corridors that will not be used for passage during work.
    ii. Install barriers in all openings larger than 4’ x 8’, consisting of wood or metal framing and 6-mil polyethylene sheeting.

B. Preparation

1. Shut down and isolate heating, cooling and ventilation systems and lock-out/tag-out power as necessary.
2. Provide negative air machines to create a pressure differential in the contained area. Contractor shall provide an additional negative air machine per containment as backup in case of machine failure. Negative air machines shall be exhausted exterior to the building.
3. Seal off all windows, corridors, doorways, grilles, diffusers, and other penetrations or openings with two layers of 4-mil poly and tape.
4. Maintain emergency and fire exits.
5. Porous and semi-porous wall and ceiling materials that are not being cleaned or removed as part of the mold remediation work should be isolated and covered with 4-mil poly sheeting, at a minimum.

1.10 REMEDIATION PROCEDURES

A. Limit the use of any aqueous materials during remediation. If necessary, ensure that drying time is minimized (expedite drying process) to prevent further mold growth.

B. Double wrap or double-bag all demolished and removed materials in 6-mil poly sheeting or 6-mil poly bags. Seal bags or wrapping securely and HEPA vacuum before removing bags from site.

C. Dispose of contaminated materials in a landfill authorized to receive construction debris. Bags must not be opened and must be buried in a landfill; do not deliver to waste recycling facilities where unauthorized opening of bags may occur.

D. Clean all surfaces in the contaminated work areas thoroughly, including fixed items not removed, with a HEPA-filtered vacuum before opening doors or removing barriers. Use a brush attachment on the vacuum cleaner when cleaning semi-porous surfaces, such as concrete, to dislodge spores that may be trapped in surfaces pores. If vacuum cleaning does not remove dusts adequately, consider wiping surfaces with a slightly damp cloth.

E. Stop all work if there is a break in the containment barriers, or failure of the negative air pressure differential.

1.11 CLEANING AND DECONTAMINATION

A. All visible accumulations of mold contamination, debris, tools and unnecessary equipment shall be removed from the work area.

B. HEPA-vacuum and wipe all surfaces within containment. Follow with a final HEPA vacuuming of all surfaces.

C. Remove all remaining tools, cleaning materials and waste from the work area.

1.12 WASTE DISPOSAL AND EQUIPMENT LOAD-OUT

A. When preparing equipment for load-out, seal openings to prevent escape of internal contamination, or open up equipment, remove filters and make equipment interiors accessible for cleaning and decontamination.

B. Packaging mold contaminated waste and debris:

1. All mold-contaminated waste including debris, containment poly, critical barrier materials, personal protective equipment, vacuum and negative air machine HEPA filters and other mold-contaminated items shall be properly packaged for disposal.
2. Use double 6 mil bags with “gooseneck” seal, or other impermeable containers.
3. Wrap large or irregular items in 2 layers of 6 mil poly sheeting and seal with tape.
4. Sharp, jagged or other items that may puncture poly shall be packaged in rigid impermeable containers such as drums or boxes or wrapped in alternative protective covering before sealing in double bags or double layers of 6 mil poly.
5. Mold-contaminated waste shall be disposed in landfills accepting construction debris.

Waste shipment records shall be returned to the Project Manager for inclusion in the final report.

1.13 DEMOBILIZATION

A. The Project Manager shall provide written notification of clearance for each work area. The Contractor may tear down only after receipt of the written notification.

B. Remove critical barriers and seals.

C. Walk-through shall be conducted and punch list completed for each cleared work area within two days of clearance testing. All punch list items shall be completed within five working days of walk through.

D. Contractor is responsible for and shall coordinate all punch list walkthroughs with all included parties such as the Architect and the CHA's Designated Representative.

**PART 2 - PRODUCTS**

(Not Used)

**PART 3 - EXECUTION**

(Not Used)

**END OF SECTION**

**SECTION 02 26 11**

**SUMMARY OF EXISTING SITE CONDITIONS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings

1.2 APPLICABILITY

A. This environmental summary is for information purposes only. Contractor shall become familiar with all site conditions prior to Work.

1.3 INTRODUCTION

A. Related Work

1. All Work

1.4 AVAILABLE ENVIRONMENTAL ASSESSMENT DOCUMENTS

A. Section 00 31 24: Phase I Environmental Site Assessment, prepared by Carnow Conibear.

1.5 SITE DESCRIPTION

A. The CHA Vivian Gordon Harsh Apartments is a multi-unit senior residential property comprised of one-hundred and twenty-three (123) one-bedroom apartments contained in a single fourteen-story building on an approximately 1.3 acre site. An off-street, surface parking lot with 34 spaces is located to the north of the building.

The building hosts on-site management offices as well as a variety of common (non-dwelling) spaces.

Gross building square footage is approx. 108,108 s.f. (approx. 7,722 s.f. per floor). The building has no corridor pressurization system, hot water radiant floor heating system and original plumbing risers. Electrical service and emergency generator system require service and upgrades.

1.6 SITE HISTORY

A. The Vivian Gordon Harsh Apartments is 14-Story + Penthouse Brick Masonry Building with a structural concrete frame. It is located at 4227 S Oakenwald in Chicago, Illinois. The building was designed by the architectural firm of Shaw Metz and Associates in 1965.

1.7 ENVIRONMENTAL CONDITIONS

A. Section 00 31 26.23: Operations and Maintenance Plan for Asbestos-Containing Material, prepared by Carnow Conibear.

B. Section 00 31 26.24: Operations and Maintenance Plan for Lead-Based Paint, prepared by Carnow Conibear.

C. Section 00 31 32: Geotechnical Data

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 02 41 19**

**SELECTIVE DEMOLITION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:
1. Demolition and removal of selected portions of building or structure
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Section 01 10 00 "Summary" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
2. Section 01 56 39 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
3. Section 01 73 00 "Execution" for cutting and patching procedures.
4. Section 01 35 16 "Alteration Project Procedures" for general protection and work procedures for alteration projects.
5. Section 31 10 00 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.

C. For requirements regarding handling and disposal of hazardous materials including lead and asbestos, see:
1. Section 02 82 13 “Asbestos Abatement – Prior to Demolition”.
2. Section 02 82 16 “Small Scale Drilling, Coring, and/or Anchoring Disturbances Less Than 3 Square or Linear Feet of Asbestos Containing Materials”.
3. Section 02 83 20 “Minor Disturbance of Painted Surfaces Assumed to Contain Lead”.
4. Section 02 86 13 “Hazardous and Universal Waste Management”.

### 1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to CHA.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 PREINSTALLATION MEETINGS

A. Pre-demolition Conference: Conduct conference at project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure the CHA's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of the CHA's continuing occupancy of portions of existing building and of the CHA's partial occupancy of completed Work.

D. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations. Comply with Section 01 32 33 "Photographic Documentation." Submit before Work begins. Submit before Work begins.

E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.6 CLOSEOUT SUBMITTALS

A. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.7 QUALITY ASSURANCE

A. Comply with all laws, rules and regulations of governmental authorities having jurisdiction over the demolition work.

B. Perform the demolition work in accordance with the applicable rules of the Safety Requirements for Demolition for Construction and Demolition Operations, (ANSI) A10.6-2006- Safety and Health Program Requirements for Demolition Operations.

C. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.8 FIELD CONDITIONS

A. The CHA will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so the CHA's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by the CHA as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

1. Hazardous material remediation is specified elsewhere in the Contract Documents.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

G. Conduct operations with a minimum interference to public or private thoroughfares.

H. Maintain protected egress and access at all times.

I. Do not obstruct public roadways or sidewalks without proper permits.

J. No explosives will be allowed for dismantling in anyway.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

**PART 2 - PRODUCTS**

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

D. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings and, preconstruction photographs.

1. Comply with requirements specified in Section 01 32 33 "Photographic Documentation."

3.2 FIRE PROTECTION

A. Keep stairways and exit ways unobstructed and available for use at all times.

B. Perform the demolition work in such a manner as to prevent fires. Remove debris promptly.

C. No materials shall be burned on the site.

D. Protect combustible materials against ignition during acetylene cutting operation.

E. Instruct employees in the following.

1. The location of the fire alarm box and telephone; and how to call the Fire Department without delay in the event of a fire.
2. The use of hand pumps, hose, water buckets and other fire extinguishing equipment.
3. Maintain of fire protection equipment in serviceable condition, properly located and identified, so that it will be available for immediate use.

## 3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 01 10 00 "Summary."
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Cap all utility lines abandoned or terminated by the demolition work in a manner approved by utility companies and authorities having jurisdiction.
5. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

## 3.4 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Section 01 5000 "Temporary Facilities and Controls."

B. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.

1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.

D. Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Work.

3.5 SEQUENCING OF WORK

A. Notify the CHA and obtain written approval 72 hours before commencing any demolition work.

B. Dismantle indicated materials, appurtenances, building elements and structures in an orderly and careful manner and in compliance with authorities having jurisdiction.

C. Monitor on a regular basis for indications of shifting or movement due to the dismantling operations.

D. Store items to be reused in designated area until re-installed. Seal all loose items in strong cartons and identify.

E. Do not stockpile demolition material so as to overload the building's structure.

3.6 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required to perform designated repairs and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings in concrete and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
2. All forensic openings shall be waterproofed at the end of each working day.

3. Remove all hazardous conditions such as but not limited to the following:

    a. loose bricks
    b. precast concrete
    c. poured in place concrete
    d. window assemblies
    e. coping

4. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
6. Dispose of demolished items and materials promptly. Comply with requirements in Section 01 74 19 "Construction Waste Management and Disposal."

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Store items in a secure area until delivery to CHA.
3. Transport items to CHA's storage area designated by the CHA's Designated Representative.
4. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

## 3.7 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

1. Remove masonry by toothing out the masonry.
2. Remove precast/limestone sills from jamb to jamb.

3.8 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain CHA's property, remove demolished materials from Project site. and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.9 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

**END OF SECTION**

**SECTION 02 82 13**

**ASBESTOS ABATEMENT - PRIOR TO DEMOLITION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Contract Drawings

### 1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. These specifications apply for all demolition, construction and renovation projects that require the removal and disposal of asbestos containing materials prior to the demolition of a building in accordance with all applicable regulations.

### 1.3 INTRODUCTION

A. Asbestos abatement work prior to demolition is required to follow all applicable Local, State and Federal regulations. This specification is intended to provide for the removal of friable and Category I and II non-friable asbestos-containing materials prior to a structural demolition. Abatement of these items is specified in the specifications. When only a portion of the structure is being demolished, related specifications may be referenced or included for barrier walls or related ACM in the areas to remain.

### 1.4 DEFINITIONS

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in the specifications are incorporated by reference, whether or not restated herein.

B. Abatement Contractor (AC) means the entity responsible for performing the work in the specifications and has the training and accreditation to competently perform the work. This entity shall obtain and maintain licenses required for the indoor work in the specifications.

C. ACM means Asbestos Containing Material.

D. Architect means any person or firm employed by the CHA for the purpose of designing the project.

E. Asbestos Abatement Supervisor, hereinafter referred to as “Supervisor” means any person who supervises asbestos abatement workers. This person must be trained, accredited, and meet OSHA competent person criteria for asbestos abatement.

F. CDPH means Chicago Department of Public Health.

G. Chicago Housing Authority (CHA) means the owner of the property and the authority ordering the work specified herein.

H. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

I. Competent person means one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f): in addition, for roofing materials (considered Class II work) who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor, or its equivalent.

J. Contractor means the entity responsible for performing the complete scope of work in the documents. The Contractor may elect to self-perform or subcontract out any portion of the work.

K. Drawings are those enumerated in the Schedule of Drawings, and additional drawings and sketches, if any, incorporated into the Contract by a bulletin issued by the Architect or Change Order as the Work progresses

L. Environmental Consultant (EC) means the entity with overall responsibility for the environmental aspects of the project, including design, organization, direction, and control as well as investigations, assessments and on-site supervision of project managers.

M. HEPA Filter means a High Efficiency Particulate Air filter capable of trapping 99.97% percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.

N. IDPH means the Illinois Department of Public Health.

O. OSHA means the federal Occupational Health and Safety Administration.

P. Plasticize means to apply plastic sheeting over surfaces or objects to protect them from contamination or water damage.

Q. PPE (Personal Protection Equipment) means the protective suits, head and foot covers, gloves, respirators and other items used to protect persons from asbestos or other hazards.

R. RCRA means the Resource Conservation and Recovery Act and associated regulations.

S. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

T. TCLP means the Toxicity Characteristic Leaching Procedure as specified in EPA 530/SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods 3rd edition, November 1986.

U. User or User Agency means the entity for which or on whose behalf the CHA has undertaken to cause the Work to be performed.

V. Work means the obligations of the Contractor under the Contract Documents. Work includes, unless specifically excepted by the Contract Documents, the furnishing of all materials, labor, equipment, supplies, plant, tools, scaffolding, transportation, superintendence, permits, inspections, occupancy approvals, insurance, taxes, and all other services, facilities and expenses necessary for the full performance and completion of the requirements of the Contract Documents. Work also means that which is furnished, produced, constructed, or built pursuant to the Contract Documents.

W. Work Area means the area or areas where asbestos abatement is being conducted.

1.5 WORK INCLUDED

A. The Work includes all labor, equipment, materials, and supplies necessary to perform the scope of work in the documents by the procedures described herein. The Contractor, by submitting a bid for the Work, represents itself as knowledgeable and expert in the performance of the Work, and includes all things usually and customarily necessary to provide a complete and finished job, whether specifically mentioned or not. Related work may be shown in other related documents, prepared by others, if applicable, and as listed below:

B. Removal of friable and non-friable asbestos-containing materials listed in the documents, including isolating the Work Areas, protection of adjacent areas, cleanup, proper packaging and disposal of wastes, and all other steps necessary to complete the scope of work.

C. Repair or replacement of damaged surfaces, fixtures, or furnishings in portions of the structure that will not be demolished, if any, to restore them to their pre-existing condition to the satisfaction of CHA's Designated Representative.

D. Compliance with all applicable laws, regulations, standards, and these specifications. In the case of a conflict, the Contractor shall comply with the most stringent.

E. All licenses, accreditations, permits, fees, notifications, reports, or other documents required by law, regulation, this specification, or the documents.

F. Provide project closeout documentation to the EC within thirty (30) days after final clearance. This documentation shall include but is not limited to submittals requirements specified elsewhere in the specifications.

1.6 LAWS, REGULATIONS AND STANDARDS

A. The following laws, regulations, and standards are incorporated by reference:

1. 29 CFR 1910: US OSHA General Industry Standards
2. 29 CFR 1926: US OSHA Construction Standards
3. 29 CFR 1926.1101: US OSHA Asbestos Construction Standards
4. 40 CFR Part 61: US EPA National Emissions Standards for Hazardous Air Pollutants (NESHAP), 11/90 revision
5. 40 CFR 763 Subpart E, US EPA Asbestos Model Accreditation Plan (MAP): Appendix C - Interim Final Rule
6. 11-4-2170: Chicago Building Code – Demolition and renovation safeguards

7. 11-4-2150: Environmental standards related to the demolition, renovation, asbestos abatement and maintenance, sandblasting, chemical washing, and grinding of buildings, facilities and other structures.

1.7 ASSESSMENT, MONITORING, TESTING AND ANALYSIS

A. The EC will perform inspection, testing and design services prior to the start of work, and monitoring during the project and upon its completion:

1. Prior to the start of work, the EC shall:

a. Identify suspect materials and confirm their asbestos content through review of the facility's management plan or by testing.
b. Design the project and address any design changes as requested. EC and Air Sampling Professional changes shall be submitted to the IDPH.
c. Collect background air samples before conditions are disturbed. Background samples shall be analyzed by PCM.

2. During the work, the EC shall:

a. Observe the work with sufficient frequency to ensure contractor compliance with the specifications.
b. Assure that all personnel and visitors have the proper current medical screening, respirator fit test, and training for their respective duties prior to entering a regulated area.
c. Collect air samples in and around the Work Area, as needed, to verify exposure conditions.
d. The EC may stop the work if airborne asbestos concentrations at the Work Area perimeter exceed 0.01 f/cc. Contractor shall be responsible for taking corrective action to reduce exposure levels and prevent recurrence, and cleaning adjacent areas that become contaminated by the asbestos abatement activities.

3. Upon completion of the work, the EC shall:

a. Visually inspect for visible debris. Contractor shall be required to re-clean the area or potions of areas until no visible debris remains.
b. Conduct final clearance testing as required.
c. Prepare the project report.

B. The Contractor shall provide OSHA compliance air monitoring to determine exposures to its employees in accordance with OSHA 29 CFR 1926.1101. Frequency of testing shall comply with OSHA requirements for the anticipated and actual exposure levels.

1. A written Exposure Assessment may be provided prior to the start of the work to determine the requirements for respiratory protection and frequency of OSHA monitoring for each type of activity. The contractor should note that a Negative Exposure Assessment (NEA) may be possible for many tasks.
2. Analysis may be performed on site.

C. Credentials required for testing and analysis of PCM air samples:

1. Accreditation by AIHA or AAR; or
2. Participation in the Proficiency Analytical Testing (PAT) program.
3. Certification of individual qualification to read samples on site when on site analysis is conducted.

1.8 SUBMITTALS BY THE CONTRACTOR:

*NOTE: THE FOLLOWING SHALL BE SUBMITTED TO THE EC NO LESS THAN 10 DAYS PRIOR TO THE START OF THE ASBESTOS ABATEMENT ACTIVITIES.*

A. Ten (10) day NESHAP notification to the Illinois EPA when the asbestos quantities reach or exceed 260 linear feet or 160 square feet. Two (2) day IDPH notification for asbestos abatement quantities less than 260 linear feet or 160 square feet. Submit ten (10) day notification to CDPH for all asbestos work.

1. Ten (10) day IEPA Asbestos Notification on revised form, including inspector license number and landfill permit number.
2. Evidence that all contractor employees in the Work Areas are trained and accredited in accordance with OSHA, NESHAP, and EPA MAP requirements:

   b. Current Annual refresher training certificate.
   c. Current IDPH asbestos license (optional, in lieu of initial training certificate).
   d. Current physicians written opinion.
   e. Current respirator fit test for negative pressure respirators when respirators are used.

3. Copy of OSHA exposure assessment, if available.
4. OSHA compliance air monitoring records generated during the project.
5. Waste shipment records.
6. Worker license and certification log.
7. Safety Data Sheets (SDS) for chemicals used on site.
8. Work plan and schedule.

B. Prior to beginning work, the AC shall submit required notifications to applicable regulatory agencies for buildings where asbestos abatement will take place. The AC shall provide copies of all regulatory notices to CHA and the EC within 24 hours of sending such notices to the regulatory authority. The AC shall not begin a project until such notices are provided to CHA and the EC.

**PART 2- PRODUCTS**

2.1 TOOLS AND EQUIPMENT

A. All tools and equipment shall at least conform to minimum industry standards and IDPH regulations.

B. Equipment:

1. Negative Air Machines shall provide HEPA filtration and conform to ANSI Z9.2 fabrication criteria.
2. Respirators shall be NIOSH approved for use with lead, asbestos, or other contaminants anticipated in the Work.
3. Contractor is fully responsible for complying with OSHA rules for other safety equipment, such as hard hats, safety harnesses, eye protection, gloves, footwear, and any other safety devices used on the site.
4. Pressure differential manometer with readable tape shall be provided by the Contractor including calibration documentation.

C. Tools:

1. Shovels and scoops shall be rubber or plastic, suitable for use in plasticized containment. Metal shovels are not permitted.
2. Scrapers, brushes, utility knives and other hand tools shall be of good quality and suitable for the intended uses. The Contractor shall keep an ample supply on hand for the completion of the Work.
3. Power tools such as, but not limited to saws, pneumatic chisels, brushes, sanders, and needle guns shall be equipped with shrouds and HEPA-filtered local exhaust systems to capture released particles.

2.2 MATERIALS

A. All materials shall at least conform to minimum industry standards and IDPH regulations.

B. Abatement materials:

1. Fire-retardant, poly sheeting for all applications shall be 6 mil nominal thickness for critical seals, floors, ceilings and drop cloths, and 4 mil for walls.
2. Tape shall be 2" or 3" duct tape or other waterproof tape suitable for joining poly seams and attaching poly sheeting to surfaces.
3. Spray adhesives shall be non-flammable and free of methylene chloride solvents.
4. Disposal bags shall be 6 mil.
5. Disposable suits, hoods, and foot coverings shall be TYVEK or similar.
6. Solvents shall be compatible with any primers, mastics, adhesives, paints, coatings, or other surfacing materials to be installed following their use.

**PART 3- EXECUTION**

3.1 EMPLOYEE TRAINING, QUALIFICATION AND MEDICAL SCREENING

A. Supervisors and Workers shall be trained, accredited, and licensed in accordance with IDPH rules.

1. Contractor shall keep copies of licenses, initial training course certificate, and most recent annual refresher training certificate at the jobsite at all times for all contractor personnel.
2. A Supervisor (competent person) shall be present at the worksite at all times when work under the specifications is being conducted.

B. Medical Screening. All contractor personnel shall have a current medical examination in accordance with OSHA requirements. Copies of the Physician's Written Opinions shall be kept on site.

3.2 PERMISSIBLE EXPOSURE LIMITS

A. The OSHA Permissible Exposure Limit (PEL) for worker exposure to airborne asbestos is 0.1 f/cc as an 8-hour time-weighted average (TWA).

B. The OSHA short term excursion limit for worker exposure to airborne asbestos is 1.0 f/cc for a 30-minute sample.

3.3 EXPOSURE ASSESSMENT AND MONITORING

A. The Contractor shall make a written assessment of the potential airborne asbestos fiber exposures for this project. Assessments shall conform with OSHA requirements and may be based upon:

1. Initial monitoring of representative workers who the contractor believes are exposed to the greatest airborne concentrations of asbestos, or
2. Past monitoring (within the past 12 months) or objective data for conditions closely resembling the processes, type of material, control methods, work practices and environmental conditions to be used for this project.

B. The Contractor shall perform personal monitoring in accordance with the following requirements:

1. Initially, to establish an exposure assessment when past monitoring or objective data are not available for an initial determination.
2. Periodically if the exposures are, or are expected to be, below the PEL.
3. Daily, if exposures are above the PEL.
4. Whenever there has been a change of equipment, process, control, personnel, or a new task has been initiated that may affect employee exposures, the exposure assessment shall be updated, and monitoring shall be re-instituted if exposures are unknown or are expected to exceed the PEL.

3.4 RESPIRATORY PROTECTION

B. Respiratory protection shall be worn in accordance with all applicable regulations referenced in Laws, Regulations and Standards specified elsewhere in the specifications.

3.5 HYGIENE PRACTICES

C. Eating, drinking, smoking, chewing gum or tobacco, and applying of cosmetics are not allowed in the Work Area.

D. All persons entering the Work Area are required to wear appropriate PPE, and follow the entry and exit procedures posted in the Personnel Decontamination Enclosure System.

E. Personal Protection Equipment (PPE) is required when airborne exposures are, or are expected to be above the PEL, or as needed to protect the safety of personnel and visitors. PPE may include:

1. Full body disposable suits, headgear, and footwear.
2. Gloves.
3. Hardhats.
4. Non-disposable footwear and clothing shall remain in the Work Area and shall be disposed of as contaminated waste when the job is completed.
5. Authorized visitors shall be provided with suitable PPE when PPE is required in the Work Area. The EC shall assure that visitors have proper and current medical screening and fit test, and awareness training or other appropriate training.

F. A Personnel Decontamination Facility is required when worker exposures are expected to exceed the PEL. The decontamination unit may be remotely located if not feasible to locate adjacent to the Work Area.

1. When a remote decon unit is used, personnel shall use a double-suiting procedure for traveling between the Work Area and the decon. Persons shall HEPA-vacuum the exterior of their disposable suits at the entry to the Work Area, put on a clean suit over the existing suit, and proceed to the decon unit for shower decontamination and change into street clothes.

G. When exposures are below the PEL, protective disposable suits are recommended, but not required. To exit, persons shall HEPA-vacuum down clothing at the Work Area entry and leave the Work Area. When disposable suits are used, they shall be HEPA-vacuumed, stripped off, and deposited in an asbestos disposal bag. Personnel may then leave the Work Area.

3.6 PROHIBITED ACTIVITIES

H. Dry removal or dry sweeping, except:

1. During freezing weather. In this case, temperature and weather conditions must be recorded at the start, during, and at the end of the shift.
2. On roofs with 3:1 slope or greater. In this case, roofing shall be removed in an intact condition, as much as possible.
3. For roofing areas of less than 25 square feet.
4. When equipment damage or other hazard exists. In this case, written permission from IEPA is required prior to performing dry removal.

B. Use of compressed air for cleaning.

C. Use of high speed power tools not equipped with a HEPA-filtered local exhaust or water spray system.

D. Removing respirators or other PPE in the Work Area.

E. Contractor shall not salvage or recycle building materials unrelated to abatement scope of work.

3.7 WORK AREA ISOLATION AND PREPARATION

I. General Preparation. Contractor shall:

1. Post:

a. Caution signs meeting the specifications of OSHA 29 CFR 1926.1101 (k)(6) at any location and approaches to a location where airborne concentrations of asbestos may exceed ambient background levels.
b. Decontamination and work procedures in equipment rooms and clean rooms.
c. EPA NESHAP asbestos rules (40 CFR Part 61, subparts A & M) in the clean room.
d. OSHA Asbestos Construction Standards (29 CFR 1926.1101) in the clean room.
e. List of telephone numbers in the clean room for:

1) Local hospital and/or local emergency squad
2) Security office (if applicable)
3) CHA's Designated Representative reachable 24 hours per day
4) Contractor's headquarters
5) Architects or consultants directly involved in the project

2. Secure the Work Area from entry by unauthorized persons.

C. Exterior Preparation:

1. 6 mil plastic sheeting shall be placed over the ground, foundation, or other surfaces below the abatement area.
2. Unauthorized entry shall be prevented by using appropriate barriers, such as warning tape, fencing, or other suitable barriers.
3. Nearby air intakes, grilles, and other openings into the building interior areas not being demolished above, below, or besides the Work Area that could be exposed to airborne dust shall be closed or sealed off with poly and tape.
4. All electric power in the Work Area shall be protected with ground-fault circuit interrupters.

3.8 ABATEMENT PROCEDURES

A. General Removal Requirements:

1. Asbestos materials shall be wetted and kept wet during removal.
2. ACM shall be bagged or containerized as it is removed. Wastes shall not be dropped or thrown to the ground. Unless the material is carried or passed to the ground by hand, it shall be lowered via covered, dust-tight chute, crane, hoist, or other means that prevent the wastes from being dropped or thrown.
3. Appropriate OSHA fall protection shall be provided when appropriate:

a. Scaffolding more than one section high shall be equipped with handrails and midrails designed to provide fall protection, or full-body safety harnesses shall be worn and tied off to a secure anchor point.

b. Workers in manlifts shall wear full body harnesses and tie to the tie-off point provided on the manlift basket whenever the basket is elevated from ground level.
c. Personal fall protection consisting of full body harnesses, lanyards, and OSHA-compliant lifelines, anchorage, and deceleration devices shall be provided whenever personnel are within 6 feet of an opening, hole, or edge where there is a risk of falling 6 feet or more.

D. Roofing:

1. General: Remove in an intact state to the extent feasible. ACM roof mastics, cements, underlayments, and flashings. Asbestos-containing shingles may occasionally break even when removed carefully. The fact that otherwise intact roofing materials become separated or broken does not by itself render them non-intact. However, if they become pulverized, reduced to powder or dust, they have become non-intact.

a. The Contractor shall take care to minimize the amount of roofing material damage.
b. If the materials are rendered non-intact, the AC shall employ methods to contain the dust and debris and utilize hygiene practices appropriate for friable (OSHA Class I) ACM, including PPE, decontamination units, and monitoring. Monitoring may include area samples at the Work Area perimeter to determine that airborne asbestos fibers are not being released in concentrations above the PEL.

2. Built-up roofing and asphalt shingles:

a. Power cutting machines shall be equipped with a HEPA-filtered dust collection system or shall be misted during use.
b. Dust generated by the cutting operation shall be collected with HEPA vacuums or wet cleaning methods.

3. Rigid roofing materials, such as cement asbestos shingles: remove intact and minimize breakage.

E. Transite, Galbestos sheeting (galvanized metal with a baked-on asbestos paint), Asbestos/Cement pipe, or other rigid panels shall be removed using wet methods.

F. Other:

1. Coatings, electric cable insulation or joint coverings, and other miscellaneous materials that are to be removed with the substrate or that can be removed without becoming friable may be removed as intact (OSHA Class II, EPA NESHAP Category I or II non-friable) in accordance with procedures described in General Removal Requirements and Roofing paragraphs above.
2. Coatings, and other miscellaneous materials that must be removed from the substrate or that otherwise shall become friable must be removed as non-intact (OSHA Class I, EPA NESHAP friable) in accordance with procedures described in General Removal Requirements and Roofing paragraphs above.

3.9 CLEANING AND DECONTAMINATION

A. All visible accumulations of ACM, debris, tools, and unnecessary equipment shall be removed from the Work Area.

B. Protective poly shall be folded in on itself, rolled up, placed in asbestos disposal bags, and disposed as asbestos waste.

C. Surfaces which have been exposed to friable ACM or its dust shall be HEPA vacuumed.

D. Dry sweeping of surfaces that have been exposed to friable ACM or its dust is not permitted.

3.10 FINAL CLEARANCE

E. Cleaning may be discontinued when there is no visible debris and area air monitoring results verify that exposures are below the PEL.

F. Final (aggressive) clearance sampling will be conducted by the EC. Each sample result, as determined by Phase Contract Microscopy, shall be less than or equal to 0.01 f/cc. If the sampling results indicate a concentration of airborne fibers in excess of this clearance criteria, the contractor shall re-clean the contained and/or regulated area. The Contractor shall not be released until the contained and/or regulated Work Area meets the clearance criteria.

3.11 WASTE DISPOSAL AND EQUIPMENT LOAD-OUT

G. Category I and II non-friable waste may be adequately wetted and loaded in bulk into lined receptacles, such as dumpsters or trailers. Receptacles shall be closeable and lockable to provide security and to prevent air emissions. It is the abatement contractor's responsibility to determine and provide for more stringent manifesting or packaging requirements that may be imposed by transporters or landfills.

H. Packaged friable asbestos wastes:

1. Asbestos-containing wastes, including removed ACM and debris, poly, critical barrier materials, suits, respirator filters, vacuum HEPA filters, water filters, and other asbestos-containing items shall be properly packaged for disposal.
2. Use 6 mil plastic bags with a gooseneck seal, drums, or other type of sealed container.
3. Wrap large or irregular items in 6 mil poly sheeting and seal with tape.
4. Sharp, jagged, or other items that may puncture poly shall be packaged in rigid impermeable containers such as drums or boxes, or wrapped in burlap or other protective covering before sealing in bags or poly sheeting.
5. Label containers for friable ACM waste:

    a. OSHA warning label.
    b. DOT performance-oriented hazardous material label.
    c. Name and address of generator and abatement location.

I. Removing items from the Work Area:

1. Packaged asbestos wastes shall be HEPA-vacuumed before removing from the Work Area.

J. Storage of packaged asbestos wastes shall be in a completely enclosed dumpster, or other suitable container that can be secured. The secured area shall be kept locked at all times to prevent unauthorized access.

K. Shipment of items from the project:

1. Decontaminated tools and equipment may be shipped by normal carrier to warehouse, another jobsite, or other destination.
2. For asbestos wastes:

   a. Line shipping container with 6 mil poly prior to loading packaged friable asbestos wastes.
   b. Post NESHAP placards during loading of friable asbestos wastes.
   c. Execute the NESHAP-required Waste Shipment Record (WSR) to be signed by the generator, transporter, and landfill. All WSRs shall be returned to the EC within 30 days of shipment.
   d. Only landfills approved and permitted for accepting asbestos wastes may be used for disposal.

**END OF SECTION**

**SECTION 02 82 14**

**ASBESTOS ABATEMENT – INTERIORS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Contract drawings

### 1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. These specifications apply for all demolition, construction and renovation projects that require the removal and disposal of asbestos containing material from the inside of a commercial or public building in accordance with all applicable regulations. These specifications may not be used for a public or private school building, grades K-12.

### 1.3 INTRODUCTION

A. Asbestos abatement in interior building spaces, covered walkways or porticos connecting buildings, and on outdoor mechanical systems which condition indoor air (such as air handling units, air conditioners, cooling towers, etc.) is governed by rules established by the Illinois Department of Public Health (IDPH). These specifications address or reference the requirements for complying with IDPH, OSHA, and EPA NESHAP asbestos rules. Each and every rule requirement may not be restated in detail since trained, accredited, and licensed Contractors and individuals are required for this work and are presumed to be familiar with the relevant laws and rules. Full regulatory compliance is required, and is a part of the contract, whether specifically stated herein or not.

B. Exterior building spaces are not subject to IDPH rules unless the abatement procedures involve interior spaces of the building. Roofing, exterior transite sheeting, asbestos siding, asbestos-containing paint, caulking, glazing, flashings, cements, or other products installed on the building exterior are subject to OSHA and NESHAP rules which, in many cases are less rigorous than IDPH requirements. Abatement of these items is specified in separate, related specification sections.

### 1.4 DEFINITIONS

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in the specifications are incorporated by reference, whether or not restated herein.

B. Abatement Contractor (AC) means the entity responsible for performing the work in the specifications and has the training and accreditation to competently perform the work. This entity shall obtain and maintain licenses required for the indoor work in the specifications.

C. Architect means any person or firm employed by the CHA for the purpose of designing the project.

D. Asbestos Abatement Supervisor, hereinafter referred to as "Supervisor" means any person who supervises asbestos abatement workers. This person must be trained, accredited, and meet OSHA competent person criteria for asbestos abatement.

E. CDPH means Chicago Department of Public Health.

F. Chicago Housing Authority (CHA) means the owner of the property and the authority ordering the work specified herein.

G. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

H. Competent person means one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f): in addition, for roofing materials (considered Class II work) who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor, or its equivalent.

I. Contractor means the entity responsible for performing the complete scope of work in the Documents. The Contractor may elect to self-perform or subcontract out any portion of the work.

J. Environmental Consultant (EC) means the entity with overall responsibility for the environmental aspects of the project, including design, organization, direction, and control as well as investigations, assessments and on-site supervision of project managers.

K. HEPA Filter means a High Efficiency Particulate Air filter capable of trapping 99.97% percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.

L. IDPH means the Illinois Department of Public Health.

M. OSHA means the federal Occupational Health and Safety Administration.

N. Plasticize means to apply plastic sheeting over surfaces or objects to protect them from contamination or water damage.

O. PPE (Personal Protection Equipment) means the protective suits, head and foot covers, gloves, respirators and other items used to protect persons from asbestos or other hazards.

P. RCRA means the Resource Conservation and Recovery Act and associated regulations.

Q. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

R. TCLP means the Toxicity Characteristic Leaching Procedure as specified in EPA 530/SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods 3rd edition, November 1986.

S. Work means the obligations of the Contractor under the Contract Documents. Work includes, unless specifically excepted by the Contract Documents, the furnishing of all materials, labor, equipment, supplies, plant, tools, scaffolding, transportation, superintendence, permits, inspections, occupancy approvals, insurance, taxes, and all other services, facilities and expenses necessary for the full performance and completion of the requirements of the Contract Documents. Work also means that which is furnished, produced, constructed, or built pursuant to the Contract Documents.

T. Work Area means the area or areas where asbestos abatement is being conducted.

U. Work Site means the room or rooms undergoing asbestos abatement activities. All closets/book rooms/coat hanger rooms/vestibules/washrooms within a room are considered part of the Work Site in which abatement work has been identified on the Drawings, whether or not they are numbered separately.

1.5 SCOPE OF WORK

A. Refer to Contract Drawings and Environmental Scope Sheets.

1.6 WORK INCLUDED

A. The work includes all labor, equipment, materials, and supplies necessary to perform the Scope of Work in the Contract Documents by the procedures described herein. The Contractor, by submitting a bid for the work, represents itself as knowledgeable and expert in the performance of the work, and includes all things usually and customarily necessary to provide a complete and finished job, whether specifically mentioned or not. Related work may be shown in other related documents, prepared by others, if applicable, and as listed below:

B. Removal of friable and non-friable asbestos-containing materials listed in the Contract Documents, including pre-cleaning, moving of furnishings, establishing regulated areas, isolating the work areas, protection of adjacent areas, containment when required, cleanup and decontamination to the specified clearance levels, proper packaging and disposal of wastes, and all other steps necessary to complete the scope of work.

C. Repair or replacement of damaged surfaces, fixtures, or furnishings to restore them to their pre-existing condition to the satisfaction of the CHA's Designated Representative and EC.

D. When the Documents include lead and asbestos abatement items in the same spaces, they should be performed in the sequence and combinations that produce the most efficient results, minimize concentrated lead waste volume, and produce the least amount of total waste. That sequence will generally be:

1. Cleanup of lead dust, flakes, chips, and residues most likely to fail a TCLP test. If both lead and asbestos debris are present and mixed together, they may be cleaned up and disposed together.

2. Cleanup and removal of failed or delaminated friable asbestos-containing debris, if any.
3. Removal of friable asbestos materials and cleanup of visible residues.
4. Removal of lead-bearing architectural components.
5. Removal of non-friable asbestos items. If both asbestos and lead are on the same components, for example lead paint and asbestos-containing glazing compound, the components may be removed and disposed with both the lead and asbestos-bearing items intact.
6. Removal of lead-based paint, coatings, or surfacing material.
7. Final cleanup and decontamination of the workspace. Final air clearance (asbestos) and wipe samples (lead) may be performed concurrently.
8. When lead and asbestos final decontamination processes are combined, the more stringent cleanup procedures will apply for both.
9. Waste disposal.

    a. Hazardous waste: loose paint flakes, chips, and dust; lead-specific cleaning supplies; contaminated soil; combined final decontamination supplies; disposable suits, gloves, head covers, and foot covers; other items that fail a TCLP or other RCRA test.
    b. Special waste: friable asbestos-containing waste materials and lead-contaminated waste that has passed TCLP or other RCRA tests.
    c. Construction and demolition (C&D) debris: lead-bearing architectural components; concrete and lumber with or without tile or mastic attached; demolition debris, and other general wastes.
    d. All asbestos-containing or lead-bearing wastes, regardless of classification, shall be disposed in a landfill approved by the IEPA to accept asbestos-containing or lead-bearing waste materials.

E. Compliance with all applicable laws, regulations, standards, and these specifications. In the case of a conflict, the Contractor will comply with the most stringent.

F. Contractor is required to fully comply with IDPH rules and these specifications unless a variance is granted by IDPH. Any variances obtained by the EC will be listed in the Documents.

G. All licenses, accreditations, permits, fees, notifications, reports, or other documents required by law, regulation, this specification, or the Documents.

H. Provide project closeout documentation to the APM within thirty (30) days after final clearance. This documentation shall include, but is not limited to, items listed in paragraph 1-7, Submittals.

## 1.6 LAWS, REGULATIONS AND STANDARDS

A. The following laws, regulations, and standards are incorporated by reference:

1. 105 ILCS 105: Illinois Asbestos Abatement Act
2. 77 Ill. Adm. Code 855: Asbestos Abatement for Public and Private Schools and Commercial and Private Buildings in Illinois
3. 29 CFR 1910: US OSHA General Industry Standards
4. 29 CFR 1926: US OSHA Construction Standards
5. 29 CFR 1926.1101: US OSHA Asbestos Construction Standards
6. ASHARA: US EPA Asbestos School Hazard Abatement Reauthorization Act
7. 40 CFR Part 61: US EPA National Emissions Standards for Hazardous Air Pollutants

(NESHAP), 11/90 revision
8. 40 CFR 763 Subpart E: US EPA Asbestos Hazard Emergency Response Act (AHERA) Rules
9. 40 CFR 763 Subpart E: US EPA Asbestos Model Accreditation Plan (MAP): Appendix C - Interim Final Rule
10. City of Chicago Code 11-4-2170 (e): Performance Standards for Facility Demolitions or Renovations Requiring Asbestos Abatement

1.7 ASSESSMENT, MONITORING, TESTING AND ANALYSIS

A. The EC will perform inspection, testing and design services prior to the start of work, and during the project, and will perform testing, inspection, and monitoring services during the work and upon its completion:

1. Prior to the start of the work

a. The EC shall identify suspect materials and confirm their asbestos content through review of the building's management plan or by testing.
b. The EC will design the project and address any design changes if requested by the Architect.
c. The EC shall collect background air samples before conditions are disturbed. Background samples will be analyzed by PCM.
d. Review and approve the pre-abatement submittals submitted by the AC.

2. During the work, the EC shall:

a. Enter the work area at least every two hours to inspect the work procedures and work area integrity.
b. Maintain a daily log to record the day's events, problems, corrective actions.
c. Collect air samples inside and outside the work area, and in the breathing zone of representative persons.
d. The EC will stop the work if airborne asbestos concentrations outside the work area exceed 0.01 f/cc or the background sample levels, whichever is higher. The work may restart when the source of fiber release has been identified and corrected. Contractor will be responsible for cleaning and decontaminating the outside area if caused by the asbestos abatement activities.
e. Observe/document smoke testing of the containment by the Contractor.
f. Review original worker licenses and maintain weekly submittals from the AC.
g. Notify the EC's project designer if design changes are needed before execution.

3. Upon completion of the work, the EC shall:

a. Inspect for visible debris. Contractor shall be required to re-clean the area or portions of areas until no visible debris remains and the work area is dry.
b. Perform aggressive clearance testing by as required by AHERA and IDPH Section 855.220.
c. Collect and analyze samples in accordance with AHERA Appendix A procedures and IDPH rule section 855.170.
d. Prepare and submit the Project Manager Abatement Report to the CHA and EC within 60 working days of clearance testing. The final Project Manager is respon-

sible for completion of the project report.

B. The Contractor shall provide OSHA compliance air monitoring to determine exposures to its employees in accordance with OSHA 29 CFR 1926.1101. Frequency of testing will comply with OSHA requirements for the anticipated and actual exposure levels.

1. A written Exposure Assessment may be provided prior to the start of the work to determine the requirements for respiratory protection and frequency of OSHA monitoring for each type of activity. The Contractor should note that a Negative Exposure Assessment (NEA) may be possible for many tasks. For interior work, this would allow reduced OSHA monitoring frequency.
2. Analysis may be performed on site.

C. Credentials required for testing and analysis of PCM final clearance air samples:

1. Accreditation by AIHA or AAR; or
2. Participation in the Proficiency Analytical Testing (PAT) program.
3. Certification of individual qualification to read samples on site if site analysis is performed.

1.8 SUBMITTALS BY THE CONTRACTOR

A. To IDPH, IEPA, EC and CHA's Designated Representative at least 10 working days before commencement of work:

1. IDPH Asbestos Notification on current form, including inspector license number and landfill permit number.
2. Written permission from CHA authorizing Contractor to commence abatement.
3. CHA asbestos abatement notification to building occupants and users.

B. To EC and CHA's Designated Representative at least five days prior to commencement of Work:

1. Documentation of arrangements of transport and disposal, landfill name and location, handling procedures and PPE at the landfill, prepared and signed by the landfill.
2. Drawings or sketches for layout and construction of isolation barriers and decontamination units.
3. Respirators: NIOSH approvals and manufacturer certification of HEPA filtration for cartridges
4. Manufacturers' certifications that all HEPA vacuums, negative air pressure equipment, and other local exhaust ventilation equipment conform to ANSI Z9.2-79
5. Written notifications to rental companies for any rental equipment used.
6. Results of any performance tests for encapsulants, if applicable.
7. OSHA Exposure Assessment, if available.
8. Laboratory and analyst credentials for Contractor OSHA samples.
9. Safety Data Sheets (SDS) for chemicals used on site.
10. Work Plan and Schedule.

C. To EC and CHA's Designated Representative on the first day of abatement work:

1. Original contractor, supervisor, and worker licenses along with a copy each.
2. Initial Course Accreditation and current refresher accreditation for each supervisor and worker.
3. Physician's Written Opinions for workers and supervisors.
4. Fit test documentation for all employees, agents.

D. To EC and CHA's Designated Representative weekly during the abatement work:

1. Job progress reports detailing abatement activities, progress compared to schedule, problems and actions taken, injury reports, and equipment breakdowns.
2. Waste Shipment Records.
3. Work site Entry logs.
4. Manometer readable tape for negative pressure differentials for each negative pressure work enclosure or a log of digital readout.
5. Filter Change logs for respirators, HEPA vacuums, negative air machines, and other engineering controls.
6. OSHA compliance air monitoring data.
7. Worker license and certification log.

E. Prior to beginning work, the AC shall submit required notifications to applicable regulatory agencies and receive an Owners Authorization and Notice to Occupants from CHA for buildings where asbestos abatement will take place. The AC will provide copies of all regulatory notices to the CHA and the EPM within 24 hours of sending such notices to the regulatory authority. The AC shall not begin a project until such notices are provided to CHA and the EPM.

## PART 2 - PRODUCTS

2.1 TOOLS AND EQUIPMENT

A. All tools and equipment shall at least conform to minimum industry standards and IDPH regulations:

B. Equipment:

1. Negative Air Machines shall provide HEPA filtration and conform to ANSI Z9.2 fabrication criteria.
2. Respirators shall be NIOSH approved for use with lead, asbestos, or other contaminants anticipated in the work.
3. Contractor is fully responsible for complying with OSHA rules for other Safety equipment, such as hard hats, safety harnesses, eye protection, gloves, footwear, and any other safety devices used on the site.
4. Pressure differential manometer with readable tape shall be provided by the Contractor, including calibration documentation.

C. Tools:

1. Shovels and scoops shall be rubber or plastic, suitable for use in a plasticized containment. Metal shovels are not permitted.
2. Scrapers, brushes, utility knives and other hand tools shall be of good quality and suitable

for the intended uses. The Contractor shall keep an ample supply on hand for the completion of the work.

3. Power tools such as, but not limited to saws, pneumatic chisels, brushes, sanders, and needle guns shall be equipped with shrouds and HEPA-filtered local exhaust systems to capture released particles.
4. Buffers are not permitted.

2.2 MATERIALS

A. All materials shall at least conform to minimum industry standards and IDPH regulations.

B. Installed materials which become a part of the work such as, but not limited to, encapsulants shall be of good quality, non-lead-bearing, free of asbestos, and conform to the respective reinstallation specification sections prepared by others.

1. Contractor shall ensure that encapsulants and sealants used as primers, basecoats, or covering existing materials are compatible with the respective existing or reinstallation materials and their manufacturers' warranties.
2. Encapsulants for surfaces to which fireproofing will be applied (beams, columns, floor or roof decks, other structural members) shall be tested and rated as a component of the fireproofing system and listed in the UL Fire Resistance Directory with the specific fireproofing material to be installed.

C. Abatement Materials

1. Fire-retardant Poly sheeting for all applications shall be 6 mil nominal thickness for critical seals, floors, ceilings and drop cloths, and 4 mil for walls.
2. Tape shall be 2" or 3" duct tape or other waterproof tape suitable for joining poly seams and attaching poly sheeting to surfaces.
3. Spray adhesives shall be non-flammable and free of methylene chloride solvents.
4. Disposal bags shall be 6 mil.
5. Disposable suits, hoods, and foot coverings shall be TYVEK or similar.
6. Solvents shall be compatible with any primers, mastics, adhesives, paints, coatings, or other surfacing materials to be installed following their use.

**PART 3 - EXECUTION**

3.1 EMPLOYEE TRAINING, QUALIFICATION AND MEDICAL SCREENING

A. Supervisors and Workers shall be trained, accredited, and licensed in accordance with IDPH rules and regulations.

1. Contractor shall keep copies of licenses and most recent annual refresher training certificate at the jobsite at all times for all Contractor personnel.
2. An IDPH- licensed supervisor (competent person) shall be present at the worksite at all times when work under this section is being conducted.
3. Current fit testing documentation.

B. Medical Screening. All Contractor personnel shall have a current medical examination in accordance with OSHA requirements. Copies of the Physician's Written Opinions shall be kept on site.

3.2 PERMISSIBLE EXPOSURE LIMITS

A. The OSHA permissible exposure limit (PEL) for worker exposure to airborne asbestos is 0.1 f/cc as an 8-hour time-weighted average (TWA).

B. The OSHA short term excursion limit for worker exposure to airborne asbestos is 1.0 f/cc for a 30 minute sample.

C. The permissible level of airborne fibers in areas adjacent to the work area is 0.01 f/cc or background level, whichever is higher, as determined by phase contrast microscopy (PCM).

1. Work shall immediately cease in any work area where the airborne fiber concentrations exceed this level.
2. The source of outside contamination shall be determined, and corrective measures (e.g. wet cleaning, changes in work practices, negative pressure containment) will be implemented to prevent recurrence.
3. The Contractor shall be responsible for cleanup of contamination in adjacent areas caused by the asbestos abatement activities at no additional cost to the CHA.

3.3 EXPOSURE ASSESSMENT AND MONITORING

A. The Contractor shall make an assessment of the airborne exposures. Assessment shall conform to OSHA requirements and may be based upon:

1. Initial monitoring of representative workers who the Contractor believes are exposed to the greatest airborne concentrations of asbestos, or
2. Past monitoring (within the past 12 months) or objective data for conditions closely resembling the processes, type of material, control methods, work practices and environmental conditions to be used for this project, or
3. In the absence of an exposure assessment, the Contractor shall perform the work in full negative pressure containment with Type C pressure-demand respirator with auxiliary SCBA escape bottle.

B. The Contractor shall perform personal monitoring in accordance with the following requirements:

1. Initially, to establish an exposure assessment when past monitoring or objective data are not available for an initial determination.
2. Periodically if the exposures are, or are expected to be, below the PEL.

a. Whenever there has been a change of equipment, process, control, personnel, or a new task has been initiated that may affect employee exposures, the exposure assessment shall be updated, and monitoring shall be reinstituted if exposures are unknown or are expected to exceed the PEL.

3. Daily, if exposures are above the PEL.

## 3.4 RESPIRATORY PROTECTION

A. Respiratory protection shall be worn by all persons potentially exposed to airborne asbestos fibers from the start of the abatement project until all areas have passed clearance air monitoring, in accordance with all applicable regulations and standards specified elsewhere in this Specification.

B. Contractors must have a respiratory protection program in compliance with all applicable regulations and standards specified elsewhere in this Specification.

## 3.5 HYGIENE PRACTICES

A. Eating, drinking, smoking, chewing gum or tobacco, and applying of cosmetics are not allowed in the work area.

B. All persons entering the work area are required to wear appropriate PPE and follow the entry and exit procedures posted in the Personnel Decontamination Enclosure System.

C. Personal Protection Equipment (PPE) shall include:

1. Full body disposable suits, headgear, and footwear.
2. Gloves.
3. Safety glasses
4. Hardhats.
5. Non-disposable footwear and clothing shall remain in the work area and shall be disposed of as contaminated waste when the job is completed.
6. Authorized visitors shall be provided with suitable PPE.

## 3.6 PROHIBITED ACTIVITIES

A. Dry removal or dry sweeping.

B. Use of compressed air for cleaning.

C. Use of high speed power tools not equipped with a HEPA-filtered local exhaust system.

D. The Contractor shall not execute abatement activities without asbestos abatement design drawings that have been signed by an IDPH licensed Asbestos Designer are on the job site. Any and all changes to containment layout and placement shall not be executed until revised design drawings that have been approved and signed by an IDPH licensed Asbestos Designer are on the job site.

E. Buffers cannot be used to remove mastic.

## 3.7 WORK AREA ISOLATION AND PREPARATION

A. General Preparation. Contractor shall:

1. Post:

   a. Caution signs meeting the specifications of OSHA 29 CFR 1926.1101 (k)(6) at any location and approaches to a location where airborne concentrations of asbestos may exceed ambient background levels.
   b. Decontamination and work procedures in equipment rooms and clean rooms.
   c. EPA NESHAP asbestos rules (40 CFR Part 61, subparts A & M) in the clean room.
   d. OSHA Asbestos Construction Standards (29 CFR 1926.1101) in the clean room.
   e. Entry and Exit Log
   f. List of telephone numbers in the clean room for:
      i. local hospital and/or local emergency squad.
      ii. Security office (if applicable).
      iii. CHA's Designated Representative reachable 24 hours per day.
      iv. Contractor's headquarters.
      v. architects or consultants directly involved in the project.

2. Secure the work area from entry by unauthorized persons.
3. Separate Work Areas from Occupied Areas

   a. Seal off all doorways and corridors which will not be used for passage during work.
   b. Install IDPH required separation barriers per section 855.430 (a) in all openings larger than 4 ft by 8 ft, consisting of wood or metal framing, a sheathing material such as plywood or drywall at least 5/8" thick on the work side, and double-layer 6-mil poly, both sides. Edges shall be caulked at the floor, ceiling, walls, and fixtures to form an air-tight seal.
   c. If the building is not totally occupied (see Section 855.430), the sheathing material may be omitted.

4. Separate Occupied areas from secured areas

   a. Install IDPH barriers per section 855.430 (b)

B. Interior Preparation.

1. Shut down and lock out electric power to all work areas. Provide temporary power from an outside source with ground-fault circuit interrupter (GFCI) at the source.
2. Shut down and isolate heating, cooling, and ventilating air systems. Remove HVAC filters, package and dispose as asbestos waste. (Need to discuss filter removal and disposal in light of replacement costs and clarify that this applies when work happens in a mech system and not in classrooms)
3. Pre-clean movable objects with HEPA vacuums or wet cleaning and remove from the work area to a location designated by the EC *where friable ACBM is involved.*
4. Pre-clean fixed items which must remain in the work area with HEPA vacuums or wet cleaning where friable ACBM is involved.
5. Wrap all fixed objects and equipment which will remain in the work area with a minimum of one layer of six mil poly.
6. Remove/protect carpeting.

7. Pre-clean the work area with HEPA vacuums or wet cleaning.
8. Seal off all windows, corridors, doorways, skylights, ducts, grilles, diffusers, and other penetrations or openings in walls, ceilings and floors with 6-mil poly and tape.
9. Cover floors with minimum one layer of fire-retardant 6-mil poly with seams staggered and taped, and extending 12" up walls. Cover walls with minimum one layer of 4-mil poly, with each wall poly overlapping each floor poly layers by 12".
10. Asbestos materials shall not be disturbed during the preparation phase.
11. Suspended ceilings shall remain in place until preparation phase is complete. Remove/protect ceiling tile per environmental scope sheets.
12. Maintain emergency and fire exits.
13. Install a five chamber Worker Decontamination Enclosure System, consisting of clean room, shower room, and dirty room separated by airlocks at least 3' wide, all with curtained doorways, of sufficient size to serve the size of the crew, and with all features required by IDPH rules.

    a. Where a remote decon unit is used (i.e. non-friable ACBM and TSI glovebag operations), the AC shall:
        i. set up the decon unit within the work area barriers
        ii. establish a negative pressure of at least 0.02" water column (wc) between the dirty room and adjacent spaces, including the clean room
        iii. provide at least 4 air changes per hour within the decon unit
        iv. use a double suiting procedure where the workers proceed to the work area exit, HEPA-vacuum gross debris from their persons using a "buddy system" put on a clean suit (either over their dirty suit or after removing the dirty suit), assure that their footwear are free of ACM contamination, and follow a designated path to the remote decon unit.
        v. Once in the decon unit, follow normal decontamination procedures.

14. Install an Equipment Decontamination Enclosure System, consisting of a washing station and a holding area, with curtained doorways and a lockable door.
15. Maintain a negative pressure of at least 0.02" water column (wc) between each contained area and adjacent spaces 24 hours a day using negative air machines vented to the outside, from the start of abatement work to final clearance. Backup negative air machines shall be available onsite in case of machine failure.
16. Once operational, the system shall be inspected daily with smoke tubes by the Contractor. Damages and defects will be repaired immediately upon discovery.

C. Exterior Preparation (for areas that interface with interior work)

1. 6 mil plastic sheeting shall be placed over the ground, foundation, or other surfaces below the abatement area.
2. Unauthorized entry shall be prevented by using appropriate barriers, such as warning tape, fencing, or other suitable barriers.
3. Nearby air intakes, grilles, and other openings into the building interior shall be sealed off with poly and tape.
4. The Contractor shall be responsible for cleanup of any adjacent areas that become contaminated as a result of the abatement activities at no additional cost to the CHA.

## 3.8 ABATEMENT PROCEDURES

A. Removal:

1. Asbestos materials shall be adequately wetted and kept adequately wet during removal.
2. ACM waste shall be bagged or containerized as it is removed.
3. Work areas shall be kept wet until visible material is cleaned up.

B. Encapsulation:

1. Damaged or missing areas of existing materials shall be repaired with non-asbestos substitutes, where appropriate.
2. Loose or hanging ACM shall be removed using appropriate removal procedures.
3. Bridging encapsulants shall be applied in accordance with manufacturer's instructions.
4. Penetrating encapsulants shall be applied to penetrate existing materials to the substrate.
5. Encapsulants shall be applied with airless spray equipment.
6. Encapsulated ACM shall be labeled as asbestos to prevent future unprotected disturbance.

C. Enclosure:

1. Locations where openings for hangers, supports, framing, or other attachments must be made in the ACM must be misted with water and kept damp to reduce airborne fiber release. Tools used to drill, cut, or otherwise disturb the ACM during attachment installation shall be equipped with a HEPA-filtered local exhaust system.
2. Loose or hanging ACM shall be removed using removal procedures.
3. Damaged areas shall be repaired with non-asbestos materials.
4. Utilities or other items requiring access shall be relocated outside of the enclosure area. Once enclosures are installed, they shall not be opened or disturbed.
5. Enclosure materials shall be impact resistant and provide an airtight barrier.
6. Enclosures shall be labeled that they contain asbestos materials to prevent future unprotected disturbance.

## 3.9 CLEANING AND DECONTAMINATION

A. Cleaning and decontamination of abatement areas, excluding glovebag areas, are as follows:

B. All visible accumulations of ACM, debris, tools, and unnecessary equipment shall be removed from the work area.

C. Post abatement clean:

1. Wet clean all surfaces and remove excess water.
2. Wait 12 hours before proceeding further to allow dust and fibers to settle.
3. Remove inner layer of poly and dispose as ACM waste.
4. Critical barriers on windows, doors, penetrations, and other openings shall remain in place and negative air system shall remain in continuous operation until final clearance tests have passed.
5. Remove all tools, cleaning materials, remaining wastes from the work area. Tools and equipment shall be cleaned before removal.
6. Post Abatmeent Clean shall be determined and documented by the EC.

D. Visual inspection: EC and Contractor shall jointly inspect the work area for visible residue and

excess water and, if observed, repeat the clean cycle until residues are not detected and work area is dry.

E. Apply lock-down encapsulants where specified in the Documents.

F. EC will inform AC if the work area is ready for final clearance testing.

3.10 FINAL CLEARANCE

A. Final clearance testing (aggressive methods) shall be performed after 12 hours have lapsed since the final cleaning, and when visual inspection has been completed and no visible water or condensation remains.

a. Work areas shall be tested using aggressive sample collection methods Perform aggressive clearance testing by as required by AHERA and IDPH Section 855.220. Collect and analyze samples in accordance with IDPH rule section 855.170.

B. If final clearance test(s) fail, the AC is responsible for repeating the cleaning sequence as necessary until final clearance tests are successful. All expenses associated with the collection and analysis of additional final clearance tests are the responsibility of the AC.

3.11 SPECIAL PROCEDURES

A. Less stringent requirements may apply in a number of cases.

B. Variances from IDPH Regulations. Variances may be requested and approved by the IDPH. These less stringent procedures may only be used when they have been requested by the Project Designer and approved by the IDPH on a case-by-case basis.

1. Variances that have been applied for the project will be listed in the Documents. These variances may or may not be approved by the IDPH.
2. The Contractor is encouraged to request additional variances it believes will be beneficial to the project. Such requests shall be submitted to the EC's Project Designer as a value engineering proposal which references the IDPH regulation section, describes the procedure variations, includes information which supports the efficacy and benefits of the alternative procedures, and offers appropriate cost savings.
3. Otherwise the Contractor is required to fully adhere to the requirements of this specification. Failure to obtain a variance shall not constitute a change in the requirements of these documents.

C. Operations and Maintenance Procedures where minor areas of ACM must be disturbed for building repairs, such as drilling holes in walls or floors, cleaning small areas to allow installation of fixtures, smoke detectors, etc. The Documents shall state if these procedures are allowed for a particular project or task.

1. Submit an asbestos notification to the IDPH for quantities over 3 linear or square feet.
2. Licensed abatement workers are required, but a licensed abatement contractor is not mandatory for work less than 3 linear or square feet.
3. Shut down heating, cooling, or ventilating air systems to prevent fiber dispersal to other areas.

4. Seal off openings in the work area, including windows, doorways, vents, and other openings with 6 mil poly sheeting and tape.
5. Lay an impermeable drop cloth under the work.
6. Wear appropriate PPE and at least a 1/2 mask APR respirator. Note that OSHA still requires an exposure assessment and respirators that are appropriate for the expected airborne fiber concentrations.
7. Use wet removal methods.
8. Wet clean work area, leaving no visible residue.
9. Package and dispose of asbestos-containing waste as specified in the waste disposal Article of this Section.

D. Glovebag Procedure. Glovebags may be used to remove pipe and duct insulation.

1. Normal IDPH Notification requirements apply to quantities of more than 3 linear or square feet.
2. Glovebag removal will require a single layer, 6 mil poly tent containment (mini-containment) with negative pressure air filtration.
3. Monitoring will be performed for each contained area by the EC:

    a. 1 personal sample
    b. 1 area sample
    c. 1 area sample at each negative pressure machine exhaust

4. Glovebag construction shall be 6 mil poly with seamless bottom, suitable for the intended use (straight runs, fittings, elbows, vertical pipes, etc.) without modification.
5. At least two licensed workers shall perform glovebag operations.
6. Workers shall wear full body PPE and at least a 1/2 mask APR respirator. Note here, too, that OSHA still requires an exposure assessment and respirators that are appropriate for the expected airborne fiber concentrations.
7. Prior to use, all loose or damaged material adjacent to the operation shall be wrapped in two layers of 6 mil poly or otherwise be rendered intact.
8. Work Practices shall include:

    a. installation to completely cover the circumference of pipe or other structure. Pipe insulation diameter shall not exceed 1/2 the bag working length above the glove sleeves.
    b. smoke test for leaks and seal any leaks prior to use.
    c. glove bag shall be single use and not moved once it is placed.
    d. wet removal methods on the materials to be removed and wet cleaning to remove all visible ACM from the pipe or structure surfaces.
    e. not to be used on surfaces having temperatures greater than $150^0$F.
    f. spray down the interior surfaces of the bag, substrate, and removed ACM.
    g. first and second cleaning, waiting at least 12 hours following each cleaning.
    h. wet down remaining ACM surfaces or seal with encapsulant.
    i. seal off the lower portion of the bag containing the ACM waste by twisting several times and sealing with tape.
    j. collapse glovebag with a HEPA vacuum.
    k. slip a 6 mil poly waste disposal bag over the glovebag, detach the bag from the pipe, and gooseneck-seal it in the waste disposal bag.
    l. dispose in accordance with this specification.

E. Resilient Floor Covering. Removal of resilient floor covering will be performed by, as a minimum, those trained in accordance with OSHA Class 2 requirements, using heat guns, infrared heat machines or other methods that remove the floor covering in whole pieces. Buffing machines may not be used for removal of mastic. The Contractor shall insure that no damage is caused to the area or equipment below the floor. Abatement procedures are as follows:

1. Submit the Floor Tile Project Notice at least 10 working days prior to the beginning of all asbestos resilient floor covering abatement projects.
2. Post signs so that the work area cannot be entered from any direction without observing a sign.
3. Isolate the work area from areas to remain occupied.
4. Install barriers of six mil plastic sheeting sealed with duct tape at all openings in the work area.
5. Install a curtained doorway at the entry to the work area, lock out electrical power to the room and supply required power with ground fault interruption protected circuits.
6. Wear, as a minimum, half-faced dual cartridge NIOSH-approved respirators and double disposable suits.
7. Remove floor covering without causing excessive breakage. Work will stop and appropriate IDPH design, project management and air sampling will be put in place if excessive breakage occurs (>10% of the removed floor tiles).
8. Dispose of floor covering and debris as asbestos waste.
9. HEPA vacuum the work area thoroughly following completion of the removal.
10. HEPA vacuum surface of protective clothing and dispose of clothing as asbestos waste.
11. Personal air monitoring will be performed by the contractor in accordance with OSHA.

F. Electrical Wiring Insulation: Removal of the electrical wiring insulation shall be performed by licensed asbestos abatement contractor under full-containment. This work is considered gross removal work. All work shall be performed in compliance with laws, regulations, and standards listed in the Section 1.5 of these specifications. If IDPH approves any variances for this project, they will be provided to the abatement contractor prior to the start of the project. The abatement shall be performed as follows:

1. Contractor shall provide submittals as per Section 1.7 of these specifications.
2. The contractor supervisor shall inform all abatement workers about electrical safety and require them to work in accordance with all applicable safety requirements while working on and around electrical system components.
3. Work area shall be isolated and prepared as per procedures provided in the Section 3.7 of these specifications.
4. Contractor shall verify that electrical power to wiring within the work area is locked out /Tagged out for the duration of the project until final air clearance is achieved. Contractor shall verify that a competent person has de-energized, locked out, tagged out and tested the electrical lines involved in this project to ensure lock out/tag out was successful. Water shall not be sprayed around wiring and/or other electrical system components. Moist rag or mops shall be used as needed. Contractor shall keep work area free of any standing water throughout this project.
5. Disconnect wire at both ends without cutting wire or otherwise disturbing wire insulation. Remove wires intact, by pulling them from one access point (preferably at the panel or switch) and rolling them up directly into an asbestos waste bag (or a glove-bag, where feasible).
6. HEPA vacuum shall be used continuously while wires are being pulled out, in order to

minimize the airborne dispersal of asbestos fibers. Wet rags shall be utilized to moist the wiring insulation as the wire is being pulled out and rolled-up in order to minimize the release of asbestos fibers.

7. The conduit and other surfaces which were in contact with wires shall be cleaned utilizing HEPA Vacuum. Moist rags/sponges shall be pulled through the conduits so as to clean the conduit surfaces after wires have been pulled out of the conduit.
8. Cleaning and Decontamination of work area shall be performed as per Section 3.9 of this specification. Contractor shall keep the work area free of any standing water throughout this project. Water shall not be sprayed around wiring and/or other electrical system components. HEPA vacuum and moist rags shall be used for cleanup and decontamination.
9. Clearance of the work area shall be performed as per Section 3.10 of this specification.

## 3.12 WASTE DISPOSAL AND EQUIPMENT LOAD-OUT

A. Preparing equipment for load-out.

1. Seal openings to prevent escape of internal contamination; or open up equipment, remove filters, and make equipment interiors accessible for cleaning and decontamination.
2. HEPA vacuum and wet wipe all equipment before removal

B. Packaging asbestos wastes:

1. All asbestos-containing wastes, including removed ACM and debris, containment poly, critical barrier materials, suits, respirator filters, vacuum and negative air machine HEPA filters, water filters, and other asbestos-containing items shall be properly packaged for disposal.
2. Use double 6 mil plastic bags with “gooseneck” seal, or other impermeable containers.
3. Wrap large or irregular items in 2 layers of 6 mil poly sheeting, seal with tape, and affix required labeling.
4. Sharp, jagged, or other items (floor tiles, screws, nails, metal debris, wood etc.)that may puncture poly shall be packaged in rigid impermeable containers such as drums or boxes, or wrapped in burlap or other protective covering before sealing in double bags or double layers of 6 mil poly.
5. Label containers:

    a. OSHA warning label.
    b. DOT performance-oriented hazardous material label.
    c. Name and address of generator and abatement location.

C. Removing items from the work area:

1. Packaged asbestos wastes, non-porous debris (such as ceiling grid, doors, hardware, and other items that can be decontaminated), and equipment shall be wet cleaned, moved into the equipment decontamination enclosure system, cleaned a second time, and moved into the holding area.
2. Containers and equipment shall be removed from the holding area by workers in clean PPE and respirators who enter from the uncontaminated side (outside). The equipment decontamination enclosure system shall not be used to enter or exit the work area.
3. Waste shall be placed in a cart and covered. A plastic runner shall be placed on the floor

to the waste storage area. The loaded cart shall be carefully taken to and unloaded into the enclosed waste storage container.

D. Storage of packaged asbestos wastes shall be in a completely enclosed dumpster or other suitable container that can be secured. The secured area shall be kept locked at all times to prevent unauthorized access.

E. Shipment of items from the project.

1. Decontaminated tools and equipment may be shipped by normal carrier to warehouse, another jobsite, or other destination.
2. For asbestos wastes:

a. Line shipping container with 6 mil poly prior to loading packaged asbestos wastes.
b. Post NESHAP placards during loading.
c. Persons performing loading operations shall wear PPE and respirators.
d. Containers and packages shall be tightly packed together to prevent shifting during transport. Large components or heavy items shall be secured to prevent shifting, and shall not be stacked on top of bags.
e. Execute the NESHAP-required Waste Shipment Record (WSR) to be signed by the generator, transporter, and landfill. All WSRs shall be returned to the EC within 30 days of shipment.
f. ACBM waste shall be transported from the work site directly to the landfill.

F. Disposal of packaged asbestos wastes.

1. Only landfills approved and permitted by Illinois for accepting asbestos wastes may be used for disposal.

## 3.13 DEMOBILIZATION

A. EC shall inspect the work area for evidence of visible debris prior to releasing the area for tear-down. Detection of contamination will require additional cleaning and re-testing of the work area.

B. Remove critical barriers and seals.

C. Restore previously-removed items, if specified in the Documents:

1. Re-mount fixtures and other previously dismounted objects.
2. Return moveable objects to their original locations.
3. Install new filters in HVAC systems where filters were previously removed.
4. Re-establish electric systems and other utilities that were shut down or locked out.

D. A punch list walk-through shall be conducted for each cleared work area within two working days of clearance testing by the EC, Contractor, building engineer, property advisor, principal, and Architect. All punch list items shall be completed within five working days of walk through.

**END OF SECTION**

**SECTION 02 82 15**

**ASBESTOS ABATEMENT – EXTERIORS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Contract drawings

### 1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. These specifications apply for all demolition, construction and renovation projects that require the removal and disposal of asbestos containing materials from the outside of buildings in accordance with all applicable regulations.

### 1.3 INTRODUCTION

A. Exterior building spaces are not covered by Illinois Department of Public Health (IDPH) rules, except for covered hallways or porticos connecting buildings and outdoor mechanical systems which condition indoor air (such as air handling units, air conditioners, cooling towers, etc.), or when interior building spaces are involved.

B. Roofing, window replacement, exterior transite sheeting, galbestos siding, asbestos-containing paint, caulking, glazing, flashings, cements, or other products installed on the building exterior are subject to Occupational Safety and Health Administration (OSHA) and National Emission Standards for Hazardous Air Pollutants (NESHAP) rules which, in many cases are less rigorous than IDPH requirements. All exterior asbestos abatement activities shall be conducted from the exterior of the building. At no time shall any work activity be staged from the interior of the building. Abatement of roofing materials requires supervision by a competent person that can be employed by the roofing contractor (refer to definition of competent person below). Abatement of these items is specified in the specifications. Related paragraphs in the Interior Abatement Section may be referenced or included where relevant.

### 1.4 DEFINITIONS

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in the specifications are incorporated by reference, whether or not restated herein.

B. Abatement Contractor (AC) means the entity responsible for performing the work in the specifications and has the training and accreditation to competently perform the work. This entity shall obtain and maintain licenses required for the work in the specifications.

C. Architect means any person or firm employed by the CHA for the purpose of designing the project.

D. Asbestos Abatement Supervisor, hereinafter referred to as "Supervisor" means any person who supervises asbestos abatement workers. This person must be trained, accredited, and meet OSHA competent person criteria for asbestos abatement.

E. CDPH means Chicago Department of Public Health.

F. Chicago Housing Authority (CHA) means the Owner of the property and the authority ordering the work specified herein.

G. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

H. Competent person means one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, as specified in 29 CFR 1926.32(f): in addition, for roofing materials (considered Class II work) who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan (40 CFR 763) for supervisor, or its equivalent.

I. Contractor means the entity responsible for performing the complete scope of work in the bid documents. The Contractor may elect to self-perform or subcontract out any portion of the work.

J. Environmental Consultant (EC) means the entity with overall responsibility for the environmental aspects of the project, including design, organization, direction, and control as well as investigations, assessments and on-site supervision of project managers.

K. Exposure Assessment is defined as a demonstration by the employer that employee exposure during an operation is or will be consistently below the Personal Exposure Limits set by OSHA.

L. HEPA Filter means a High Efficiency Particulate Air filter capable of trapping 99.97% percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.

M. IDPH means the Illinois Department of Public Health.

N. OSHA means the federal Occupational Health and Safety Administration.

O. Plasticize means to apply plastic sheeting over surfaces or objects to protect them from contamination or water damage.

P. PPE (Personal Protection Equipment) means the protective suits, head and foot covers, gloves, respirators and other items used to protect persons from asbestos or other hazards.

Q. RCRA means the Resource Conservation and Recovery Act and associated regulations.

R. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

S. TCLP means the Toxicity Characteristic Leaching Procedure as specified in EPA 530/SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods 3rd edition, November 1986.

T. Work means the obligations of the Contractor under the Contract Documents. Work includes, unless specifically excepted by the Contract Documents, the furnishing of all materials, labor, equipment, supplies, plant, tools, scaffolding, transportation, superintendence, permits, inspections, occupancy approvals, insurance, taxes, and all other services, facilities and expenses necessary for the full performance and completion of the requirements of the Contract Documents. Work also means that which is furnished, produced, constructed, or built pursuant to the Contract Documents.

U. Work Area means the area or areas where asbestos abatement is being conducted.

V. Work Site means the room or rooms undergoing lead abatement activities. All closets/book rooms/coat hanger rooms/vestibules/washrooms within a room are considered part of the Work Site in which abatement work has been identified on the Drawings, whether or not they are numbered separately.

1.5 WORK INCLUDED

A. The work includes all labor, equipment, materials, and supplies necessary to perform the scope of work in the Contract Documents by the procedures described herein. The Contractor, by submitting a bid for the work, represents itself as knowledgeable and expert in the performance of the work, and includes all things necessary to provide a complete and finished job, whether specifically mentioned or not. Related work may be shown in other related documents, prepared by others, if applicable.

B. Removal of friable and non-friable asbestos-containing materials listed in the Contract Documents, including isolating the work areas, protection of adjacent areas, cleanup, proper packaging and disposal of wastes, and all other steps necessary to complete the scope of work.

C. Repair or replacement of damaged surfaces, fixtures, or furnishings to restore them to like new condition to the satisfaction of the Architect or CHA's Designated Representative or EC.

D. When the Contract Documents include lead and asbestos abatement items in the same spaces, typically windows, painted-over transite sheeting, and flashings, the work should be performed in the sequence and combinations that produce the most efficient results, minimize concentrated lead waste volume, and produce the least amount of total waste. That sequence will generally be:

1. Cleanup and removal of lead dust, flakes, chips, peeling paint, and residues most likely to fail a TCLP test.
2. Removal of asbestos materials and cleanup of visible residues.
3. Removal of lead-bearing architectural components.
4. Removal of non-friable asbestos items. If both asbestos and lead are on the same components, for example lead paint and asbestos-containing glazing compound, the components may be removed and disposed with both the lead and asbestos-bearing items intact.
5. Final cleanup and decontamination of the work space. Final air clearance (asbestos) and wipe samples (lead) may be performed concurrently.

6. When lead and asbestos final decontamination processes are combined, the more stringent cleanup procedures will apply for both.
7. Waste disposal.

    a. Classified waste: loose paint flakes, chips, and dust; lead-specific cleaning supplies; contaminated soil; combined final decontamination supplies; disposable suits, gloves, headcovers, and foot covers; other items that fail a TCLP test.
    b. Special waste: friable asbestos-containing waste materials and lead-contaminated waste that has passed TCLP or other RCRA tests.
    c. Construction and demolition (C&D) debris: non-friable asbestos-containing waste materials (such as, but not limited to intact transite, mastics, packing, caulking); lead-bearing architectural components; demolition debris, and other general wastes.
    d. All asbestos-containing or lead-bearing wastes, regardless of classification, shall be disposed in an IEPA-approved landfill within the State of Illinois to accept asbestos-containing or lead-bearing waste materials.

E. Compliance with all applicable laws, regulations, standards, and these specifications. In the case of a conflict, the Contractor will comply with the most stringent.

F. All licenses, accreditations, permits, fees, notifications, reports, or other documents required by law, regulation, this specification, or the Documents.

G. Provide project closeout documentation to the EC within thirty (30) days after final clearance. This documentation shall include, but is not limited to, items listed in paragraph 1-7, Submittals.

## 1.6 LAWS, REGULATIONS AND STANDARDS

A. The following laws, regulations, and standards are incorporated by reference:

1. 29 CFR 1910 - US OSHA General Industry Standards
2. 29 CFR 1926 - US OSHA Construction Standards
3. 29 CFR 1926.1101 - US OSHA Asbestos Construction Standards
4. 40 CFR Part 61 - US EPA National Emissions Standards for Hazardous Air Pollutants (NESHAP), 11/90 revision
5. 40 CFR Part 763 Subpart E - US EPA Asbestos Model Accreditation Plan (MAP): Appendix C Interim Final Rule

## 1.7 ASSESSMENT, MONITORING, TESTING AND ANALYSIS

A. The EC will perform inspection, testing and design services prior to the start of work, and during the project, if necessary. The EC will also perform testing, inspection, and monitoring services during the work and upon its completion:

1. Prior to the start of the work, the EC shall

    a. Identify suspect materials and confirm their asbestos content through review of the school's documentation or by testing;
    b. Design the project and address any design changes as requested. Approved

changes shall be submitted to the IDPH, when necessary.

2. During the work, the EC shall:

   a. Observe the work periodically, with sufficient frequency to ensure Contractor compliance.
   b. Collect area air samples in and around the work area, as needed, to verify exposure conditions.
   c. Stop the work if airborne asbestos concentrations at the work area perimeter exceed 0.01 f/cc. Contractor will be responsible for taking corrective action to reduce exposure levels and prevent recurrence; cleaning adjacent areas that become contaminated by the asbestos abatement activities.
   d. Make copies of Contractor licenses from the originals.
   e. Complete design changes that are needed.

3. Upon completion of the work, the EC shall:

   a. Visually inspect for visible dust and debris, and verify the full completion of the work.
   b. Require Contractor to re-clean the area or portions of areas until no visible debris remains.
   c. Perform clearance air sampling at the completion of the work activities, when necessary.

B. The Contractor shall provide OSHA compliance air monitoring to determine exposures to its employees in accordance with OSHA 29 CFR 1926.1101. Frequency of monitoring will comply with OSHA requirements for the anticipated and actual exposure levels.

1. A written Exposure Assessment with air sampling and analysis conducted 6 months or less prior to the start of the work to determine the requirements for respiratory protection and frequency of OSHA monitoring for each type of activity. The Contractor should note that a Negative Exposure Assessment (NEA) may be possible for these tasks.
2. Analysis may be performed on site.

C. Credentials required for testing and analysis of PCM air samples:

1. Air sampling shall be conducted by an IDPH licensed Air Sampling Professional.
2. Accreditation by AIHA or AAR; or
3. Participation in the Proficiency Analytical Testing (PAT) program.

1.8 SUBMITTALS BY THE CONTRACTOR:

A. The following shall be submitted to CHA's Designated Representative and EC no less than 10 days prior to the start of the asbestos abatement work activities.

B. Ten (10) day NESHAP notification to the Illinois EPA and the Chicago Department of Public Health when the asbestos quantities reach or exceed 260 linear feet or 160 square feet. Two (2) day IDPH notification with a copy to CDPH for asbestos abatement quantities less than 260 linear feet or 160 square feet.

1. Ten (10) day IEPA Asbestos Notification on revised form, including inspector license number and landfill permit number.
2. Evidence that all abatement contractor employees in the work areas are trained and accredited in accordance with OSHA, NESHAP, and EPA MAP requirements:

    a. Current Annual refresher training certificate.
    b. Current IDPH asbestos license
    c. Current physician's written opinion
    d. Current respirator fit test for negative pressure respirators when respirators are used.

3. Copy of OSHA Exposure Assessment, with air sampling and analysis conducted 6 months or less prior to the start date of the abatement project.
4. OSHA compliance air monitoring records generated during the project.
5. Waste Shipment Records.
6. Worker license and certification log.
7. Material Safety Data Sheets (MSDS) for chemicals used on site.
8. Work Plan and Schedule.

C. Prior to beginning work, the Contractor shall submit required notifications to applicable regulatory agencies for buildings where asbestos abatement will take place. The Contractor will provide copies of all regulatory notices to CHA's Designated Representative and the EC within 24 hours of sending such notices to the regulatory authority. The Contractor shall not begin a project until such notices are provided to CHA's Designated Representative and the EC.

## PART 2 - PRODUCTS

2.1 TOOLS AND EQUIPMENT

A. All equipment shall at least conform to minimum industry standards:

B. Equipment:

1. Respirators shall be NIOSH approved for use with lead, asbestos, or other contaminants anticipated in the work.
2. Contractor is fully responsible for complying with OSHA rules for other Safety equipment, such as hard hats, safety harnesses, eye protection, gloves, footwear, and any other safety devices used on the site.

C. Tools:

1. Ladders, scaffolding and all other rigging devices shall be constructed in a safe manor meeting all regulatory and permitting requirements.
2. Power tools such as, but not limited to saws, pneumatic chisels, brushes, sanders, and needle guns shall be equipped with shrouds and HEPA-filtered local exhaust systems to capture released particles. Power tools shall also be grounded using a ground fault Circuit Interrupter (GFI) breaker or outlet.

2.2 MATERIALS

A. Installed materials which become a part of the work such as, but not limited to, encapsulants foam sealants and permanent enclosures shall be of good quality, non-lead-bearing, free of asbestos, and conform to the respective reinstallation specification sections.

1. Contractor shall ensure that encapsulants and sealants used as primers, basecoats, fillers or covering existing materials are compatible with the respective existing or reinstallation materials and their manufacturers' warranties.

B. Abatement materials

1. Poly sheeting for all applications shall be 6 mil nominal thickness.
2. Tape shall be 2 inch or 3 inch duct tape or other waterproof tape suitable for joining poly seams and attaching poly sheeting to surfaces.
3. Spray adhesives shall be non-flammable and free of methylene chloride solvents.
4. Disposal bags shall be 6 mil.
5. Disposable suits, hoods, and foot coverings shall be TYVEK or similar.
6. Solvents shall be compatible with any primers, mastics, adhesives, paints, coatings, or other surfacing materials to be installed following their use.

**PART 3 - EXECUTION**

3.1 EMPLOYEE TRAINING, QUALIFICATION AND MEDICAL SCREENING

A. Supervisors and Workers shall be trained, accredited, and licensed in accordance with IDPH rules and regulations:

1. Contractor shall keep copies of licenses, initial training course certificate, and most recent annual refresher training certificate at the jobsite at all times for all Contractor personnel.
2. A Supervisor (competent person) shall be present at the work site at all times when work under this section is being conducted.

B. Medical Screening. All Contractor personnel shall have a current medical examination in accordance with OSHA requirements. Copies of the Physician's Written Opinions shall be kept on site along with a current fit test certificate.

3.2 PERMISSIBLE EXPOSURE LIMITS

A. The OSHA permissible exposure limit (PEL) for worker exposure to airborne fibers is 0.1 f/cc as an 8-hour time-weighted average (TWA).

B. The OSHA short term excursion limit (STEL) for worker exposure to airborne fibers is 1.0 f/cc for a 30 minute sample.

3.3 EXPOSURE ASSESSMENT AND MONITORING

A. The Contractor shall make an assessment of the airborne exposures. Assessment shall conform

to OSHA requirements and may be based upon:

1. Initial monitoring of representative workers who the Contractor believes are exposed to the greatest airborne concentrations of asbestos, or
2. Past monitoring (within the past 12 months) or objective data for conditions closely resembling the processes, type of material, control methods, work practices and environmental conditions to be used for this Documents, or
3. In the absence of an exposure assessment the Contractor shall perform the work in full negative pressure containment with Type C pressure-demand respirator with auxiliary SCBA escape bottle.

B. The Contractor shall perform personal monitoring in accordance with the following requirements:

1. Initially, to establish an exposure assessment when past monitoring or objective data are not available for an initial determination.
2. Daily, if the exposures are, or are expected to be, above the PEL of 0.1 f/cc.
3. Periodically if the exposures are, or are expected to be, below the PEL.
4. Whenever there has been a change of equipment, process, control, personnel, or a new task has been initiated that may affect employee exposures, the exposure assessment shall be updated, and monitoring shall be reinstituted if exposures are unknown or are expected to exceed the PEL.
5. Area Monitoring is required at the perimeter of the work area to verify that exposures to adjacent areas are below the PEL.

## 3.4 RESPIRATORY PROTECTION

A. Respiratory protection shall be worn by all persons potentially exposed to airborne asbestos fibers from the start of the abatement project until air monitoring analysis results prove otherwise.

## 3.5 HYGIENE PRACTICES

A. Eating, drinking, smoking, chewing gum or tobacco, and applying of cosmetics are not allowed in the work area.

B. All persons entering the work area shall wear appropriate PPE.

C. When the use of a Personnel Decontamination Enclosure System is deemed necessary by the EC, the abatement contractor shall follow all entry and exit procedures posted in the Personnel Decontamination Enclosure System.

D. Personal Protection Equipment (PPE) shall include:

1. Full body disposable suits, headgear, and footwear.
2. Gloves.
3. Hard hats.
4. Non-disposable footwear and clothing shall remain in the work area and shall be disposed of as contaminated waste when the job is completed.
5. Authorized visitors shall be provided with suitable PPE when required in the work area.

6. PPE is required when exposures are, or are expected to be above the PEL.

E. A Personnel Decontamination (decon) Facility is required when worker exposures are expected to be above the PEL. The Decontamination unit may be remotely located if not feasible to locate adjacent to the work area.

1. Establish a negative pressure of at least 0.02 inch wc between the dirty equipment room and adjacent spaces, including the clean room. Assume Negative Air Machines (NAM) operate at 80% design capacity.
2. Provide at least 4 air changes per hour within the decon unit
3. All personnel shall use a double-suiting procedure for traveling between work areas and decon. Persons shall HEPA-vacuum the exterior of their disposable suits at the entry to the work area, put on a clean suit over the existing suit, and proceed to the decon unit for shower decontamination and change into street clothes.

F. To exit, persons shall HEPA-vacuum down clothing at the work area entry, and leave the work area. When disposable suits are used, they shall be HEPA-vacuumed, stripped off, and deposited in an asbestos disposal bag. Personnel may then leave the work area.

## 3.6 PROHIBITED ACTIVITIES

A. Dry removal or dry sweeping, except:

1. During freezing weather. In this case, temperature and weather conditions must be recorded at the start, during, and at the end of the shift.
2. On roofs with 3:1 slope or greater. In this case, roofing shall be removed in an intact condition, as much as possible.
3. When equipment damage or other hazard exists. In this case, written permission from IEPA is required prior to performing dry removal.

B. Use of compressed air for cleaning.

C. Use of high speed power tools not equipped with a HEPA-filtered local exhaust system.

D. Eating, drinking, smoking, chewing gum, or applying cosmetics in the work area.

E. Removing respirators or other PPE in the work area.

## 3.7 WORK AREA ISOLATION AND PREPARATION

A. General Preparation

1. Post caution signs meeting the specifications of OSHA 29 CFR 1926.1101 (k)(6) at any location and approaches to a location where airborne concentrations of asbestos may exceed ambient background levels.
2. Secure the work area from entry by unauthorized persons.

B. Exterior Preparation

1. 6 mil plastic sheeting shall be placed over the ground, foundation, or other surfaces below

the abatement area.

2. Unauthorized entry shall be prevented by using appropriate barriers, such as warning tape, fencing, or other suitable barriers.
3. Nearby air intakes, grilles, windows, and other openings into the building interior above, below, or beside the work area that could be exposed to released airborne dust shall be closed or otherwise sealed off with poly and tape.
4. All electric power in the work area shall be protected with Ground-Fault Circuit Interrupters.

## 3.8 ABATEMENT PROCEDURES

A. General Removal Requirements:

1. Asbestos materials shall be wetted and kept wet during removal.
2. ACM shall be bagged or containerized as it is removed. Wastes shall not be dropped or thrown to the ground. Unless the material is carried or passed to the ground by hand, it shall be lowered via covered, dust-tight chute, crane, hoist, or other means that prevent the wastes from being dropped or thrown.
3. Appropriate OSHA protection shall be provided when working from exterior access:

    a. Scaffolding shall be equipped with handrails and midrails designed to provide fall protection, or full-body safety harnesses shall be worn and tied off to a secure anchor point.
    b. Workers in manlifts shall wear full body harnesses and tie to the tie-off point provided on the manlift basket whenever the basket is elevated from ground level.
    c. The Contractor shall ensure that scaffolding, manlifts and the workers erecting and using the equipment meet all federal, state and local regulations and requirements including the acquisition of all required permits for the erection and use of such equipment.

B. Window Replacements: Asbestos-containing materials are most likely to be found in exterior caulking and glazing putty. Windows may be removed under this section if ACM is handled from the building exterior. If ACM materials must be accessed from inside the building or ACM wastes must be transported through the building interior, then IDPH-regulated Interior Asbestos Abatement for Interiors, Section 028214, requirements will apply at no additional cost to the CHA. For exterior work:

1. Close windows and seal from the inside by covering with 6 mil poly and tape, or by applying tape directly to window joints and seams.
2. Any ACM not required to be disturbed for window removal should be left in place (e.g. window pane glazing).
3. ACM that must be disturbed (e.g. caulking at the edge of the window frame) must be removed completely, including three-dimensional residues.
4. Collect debris and deposit in asbestos waste bags as the work proceeds. Do not allow wastes to accumulate on surfaces.
5. Abate ACM and LBP on all window components to remain in place.

C. Roofing

1. General: Remove ACM roof mastics, cements, underlayments, and flashings in an intact state to the extent feasible. Asbestos-containing shingles may occasionally break even when removed carefully. The fact that otherwise intact roofing materials become separated or broken does not by itself render them non-intact. However, if they become pulverized, reduced to powder or dust, they have become non-intact.

    a. The Contractor shall take care to minimize the amount of roofing material damage, or;
    b. If the materials are rendered non-intact, the Contractor shall employ methods to contain the dust and debris and utilize hygiene practices appropriate for friable (OSHA Class I) ACM, including PPE, decontamination units, and monitoring. Monitoring may include area samples at the work area perimeter to determine that airborne asbestos fibers are not being released in concentrations above the PEL.

2. Built-up roofing and asphalt shingles:

    a. Power cutting machines shall be equipped with a HEPA-filtered dust collection system and shall be misted during use.
    b. Dust generated by the cutting operation shall be collected with HEPA vacuums or wet cleaning methods.

3. Rigid roofing materials, such as cement asbestos shingles: remove intact and minimize breakage.

D. Transite, Galbestos sheeting (galvanized metal with a baked-on asbestos paint), Asbestos/Cement pipe, or other rigid panels shall be removed using wet methods.

E. Other

1. Non-LBP paint and other coatings, electric cable insulation or joint coverings, and other miscellaneous materials that are to be removed with the substrate or that can be removed without becoming friable may be removed as intact (OSHA Class II, EPA NESHAP Category I or II non-friable) in accordance with procedures described in the General and Roofing Sections 3.8 A. and C.
2. Non-LBP paint, coatings, and other miscellaneous materials that must be removed from the substrate or that otherwise will become friable must be removed as non-intact (OSHA Class I, EPA NESHAP friable) in accordance with procedures described in General and Roofing Sections 3.8 A. and C.1.b.

## 3.9 CLEANING AND DECONTAMINATION

A. All visible accumulations of ACM, debris, tools, and unnecessary equipment shall be removed from the work area.

B. Protective poly shall be folded in on itself, rolled up, placed in asbestos disposal bags, and disposed as asbestos waste.

C. Surfaces which have been exposed to friable ACM or its dust shall be HEPA vacuumed.

D. Dry sweeping of surfaces which have been exposed to friable ACM or its dust is not permitted.

## 3.10 FINAL CLEARANCE

A. Cleaning may be discontinued when there is no visible debris and area air monitoring verifies that exposures are below the PEL. If any area air monitoring analysis results demonstrate results are at or above the PEL, the Contractor is responsible for repeating the cleaning as necessary until tests are satisfactory. All expenses associated with the collection and analysis of additional air monitoring tests are the responsibility of the Contractor.

## 3.11 WASTE DISPOSAL AND EQUIPMENT LOAD-OUT

A. Roofing waste may be loaded in bulk into lined enclosed receptacles, such as dumpsters or trailers. Receptacles shall be closeable and lockable to provide security and to prevent air emissions.

B. Packaged asbestos wastes:

1. Asbestos-containing wastes, including removed ACM and debris, poly, critical barrier materials, suits, respirator filters, vacuum HEPA filters, water filters, and other asbestos-containing items shall be properly packaged for disposal.
2. Use 6 mil plastic bags with gooseneck seal, or other impermeable containers.
3. Wrap large or irregular items in 6 mil poly sheeting and seal with tape.
4. Sharp, jagged, or other items that may puncture poly shall be packaged in rigid impermeable containers such as drums or boxes, or wrapped in burlap or other protective covering before sealing in bags or poly sheeting.
5. Label containers for friable ACM waste:

    a. OSHA warning label.
    b. DOT performance-oriented hazardous material label.
    c. Name and address of generator and abatement location.

C. Removing items from the work area:

1. Packaged asbestos wastes shall be HEPA-vacuumed before removing from the work area.

D. Storage of packaged asbestos wastes shall be in a completely enclosed dumpster, or other suitable container that can be secured. The secured area shall be kept locked at all times to prevent unauthorized access.

E. Shipment of items from the project.

1. Decontaminated tools and equipment may be shipped by normal carrier to warehouse, another jobsite, or other destination.

2. For asbestos wastes:

    a. Line enclosed shipping container with 6 mil poly prior to loading packaged friable asbestos wastes.
    b. Post NESHAP placards during loading of friable asbestos wastes.
    c. Execute the NESHAP-required Waste Shipment Record (WSR) to be signed by

the generator, transporter, and landfill. All WSRs shall be returned to the EC within 30 days of shipment.

d. ACM waste shall be transported from the work site directly to the landfill.

F. Disposal of packaged asbestos wastes.

1. Only landfills approved and permitted by Illinois for accepting asbestos wastes may be used for disposal.

G. A punch list walk-through shall be conducted for each cleared work area within two working days of clearance testing by the EC, Contractor, engineer, property management, Architect, and CHA's Designated Representative. All punch list items shall be completed within five working days of walk through.

**END OF SECTION**

**SECTION 02 82 16**

**SMALL SCALE DRILLING, CORING AND/OR ANCHORING DISTURBANCES LESS THAN 3 SQUARE OR LINEAR FEET OF ASBESTOS CONTAINING MATERIALS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Contract drawings

### 1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. These specifications apply for all demolition and construction activities that may include drilling, coring and/or anchoring into asbestos containing building materials or building materials assumed to contain asbestos but shall not disturb greater than a total of three (3) square feet or three (3) linear feet during the entire project work at the CHA structure.

### 1.3 INTRODUCTION

A. Disturbance of small quantities of asbestos containing materials in interior building spaces, covered walkways or porticos connecting buildings, and on outdoor mechanical systems which condition indoor air (such as air handling units, air conditioners, cooling towers, etc.) is governed by rules established by the Illinois Department of Public Health (IDPH) and the Chicago Department of Public Health (CDPH). These specifications address or reference the requirements for complying with IDPH, CDPH, OSHA, and EPA NESHAP asbestos rules. Each and every rule requirement may not be restated in detail since trained, accredited, and licensed Contractors and individuals are required for this work and are presumed to be familiar with the relevant laws and rules. Full regulatory compliance is required, and is a part of the contract, whether specifically stated herein or not.

### 1.4 DEFINITIONS

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in this Section are incorporated by reference, whether or not restated herein.

B. Abatement Contractor (AC) means the entity responsible for performing the work in this Section, with the training and accreditation to competently perform the work. This entity shall obtain and maintain any licenses required for the work in this Section.

C. Architect means the entity that assembles the overall documents and bid package and approves the work.

D. CDPH means the Chicago Department of Public Health.

E. Chicago Housing Authority (CHA) means the owner of the property and the authority ordering the work specified herein.

F. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

G. Environmental Consultant (EC) means the entity with overall responsibility for the environmental aspects of the project, including design, organization, direction, oversight and control as well as investigations, assessments, and supervision of project manager.

H. General Contractor (GC) means the entity responsible for performing the complete scope of work in the Documents. The GC may elect to self-perform or subcontract out any portion of the work. If the GC acts as the AC, it must have the same credentials, training, accreditations and licenses required by the AC.

I. HEPA Filter means a High Efficiency Particulate Air filter capable of trapping 99.97% percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.

J. IDPH means the Illinois Department of Public Health.

K. OSHA means the federal Occupational Health and Safety Administration.

L. Plasticize means to apply plastic sheeting over surfaces or objects to protect them from contamination or water damage.

M. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

N. Work Area means areas where activities that disturb small quantities of asbestos containing materials are conducted.

O. Work Site means the room or rooms or routes for construction/distribution/mounting of the electrical systems undergoing activities covered by this section. All closets/book rooms/coat hanger rooms/vestibules/washrooms within a room are considered part of the work site in which work has been identified on the drawings, whether or not they are numbered/named separately. All other areas of the building (attics, basements, hallways, crawl-spaces, etc.) are considered part of the work site, even if they are not explicitly identified in the documents.

1.5 WORK INCLUDED

**A.** The Work includes the control of dust emissions caused by construction, demolition, renovation, restoration, or related activities that disturb less than three square feet or three linear feet of asbestos containing materials including, but not limited to drilling sawing, cutting, grinding, sanding, abrading, sweeping, crushing, scraping, screwing into, or any other related processes. **IN NO CASE CAN THE TOTAL QUANTITY OF DISTURBED ASBESTOS CONTAINING MATERIALS EXCEED THREE (3) SQUARE FEET THREE OR (3) LINEAR FEET FOR THE ENTIRE PROJECT AREA AND DURATION.**

B. No visible emissions or unreasonable odors will be permitted within the work area.

C. All products/processes/equipment planned for use that will possibly cause emissions or odors shall be accompanied with SDS sheets and submitted to the Architect prior to the use of the product.

D. Use of licensed Asbestos Contractor and crew is required when building materials are confirmed to contain asbestos or assumed to contain asbestos.

1.6 LAWS, REGULATIONS AND STANDARDS

A. The Contractor is responsible for compliance with all applicable local, state and federal laws, regulations and ordinances including, but not limited to, those listed below, which are incorporated by reference.

B. The following laws, regulations and standards are incorporated by reference:

1. 29 CFR 1910: US OSHA General Industry Standards
2. 29 CFR 1926: US OSHA Construction Standards
3. 40 CFR Part 61: USEPA National Emissions Standards for Hazardous Air Pollutants (NESHAP)
4. 77 Ill. Adm. Code 855 Rules for Asbestos Abatement for Public and Private Schools and Commercial and Public Buildings in Illinois.
5. 11-4-2170: Chicago Building Code- Demolition and renovation safeguards
7. 11-4-2150: Environmental standards related to the demolition, renovation, asbestos abatement and maintenance, sandblasting, chemical washing, and grinding of buildings, facilities or other structures

**PART 2- PRODUCTS**

2.1 TOOLS AND EQUIPMENT

A. All tools and equipment shall at least conform to minimum industry standards and IDPH regulations.

B. Equipment:

1. Negative Air Machines shall provide HEPA filtration and conform to ANSI Z9.2 fabrication criteria.
2. Respirators shall be NIOSH approved for use with lead, asbestos, or other contaminants anticipated in the Work.
3. Contractor is fully responsible for complying with OSHA rules for other Safety equipment, such as hard hats, safety harnesses, eye protection, gloves, footwear, and any other safety devices used on the site.

C. Tools:

1. Shovels and scoops shall be rubber or plastic, suitable for use in a plasticized containment. Metal shovels are not permitted.

2. Scrapers, brushes, utility knives and other hand tools shall be of good quality and suitable for the intended uses. The Contractor shall keep an ample supply on hand for the completion of the Work
3. Power tools such as, but not limited to saws, pneumatic chisels, brushes, sanders, and needle guns shall be equipped with shrouds and HEPA-filtered local exhaust systems to capture released particles.

2.2 MATERIALS

A. All materials shall at least conform to minimum industry standards and IDPH regulations.

B. Installed materials which become a part of the Work such as, but not limited to, encapsulants shall be of good quality, non-lead-bearing, free of asbestos, and conform to the respective reinstallation specification sections prepared by others.

1. Contractor shall ensure that encapsulants and sealants used as primers, basecoats, or covering existing materials are compatible with the respective existing or reinstallation materials and their manufacturers' warranties.
2. Encapsulants for surfaces to which fireproofing shall be applied (beams, columns, floor or roof decks, other structural members) shall be tested and rated as a component of the fireproofing system and listed in the UL Fire Resistance Directory with the specific fireproofing material to be installed.

C. Abatement Materials:

1. Fire-retardant Poly sheeting for all applications shall be 6 mil nominal thickness for critical seals, floors, ceilings and drop cloths, and 4 mil for walls.
2. Tape shall be 2" or 3" duct tape or other waterproof tape suitable for joining poly seams and attaching poly sheeting to surfaces.
3. Spray adhesives shall be non-flammable and free of methylene chloride solvents.
4. Disposal bags shall be 6 mil.
5. Disposable suits, hoods, and foot coverings shall be TYVEK or similar.
6. Solvents shall be compatible with any primers, mastics, adhesives, paints, coatings, or other surfacing materials to be installed following their use.

**PART 3- EXECUTION**

3.1 ASBESTOS WORK DETAILS

**A.** This specification section applies only to the disturbance of asbestos materials or materials assumed to contain asbestos in quantities less than three (3) square feet or three (3) linear feet. **IN NO CASE CAN THE TOTAL QUANTITY OF DISTURBED ASBESTOS CONTAINING MATERIALS EXCEED THREE (3) SQUARE FEET OR THREE (3) LINEAR FEET FOR THE ENTIRE PROJECT AREA AND DURATION.**

B. The Contractor is responsible for verifying quantities, conditions, and logistics in the field before bidding. Any questions about the scope or clarifications shall be obtained from the Architect prior to bidding. Any interpretations of the design documents shall only be made by

the Architect.

C. The General Contractor and licensed Asbestos Contractor are responsible for security to the work area(s) during any activities covered by this Section.

D. Contractors and/or licensed Asbestos Contractors shall not move, disturb, displace or dispose of any assumed and/or confirmed asbestos containing ceiling tiles under this specification.

E. Any process that disturbs asbestos containing materials (assumed or confirmed) shall be conducted by a licensed Asbestos Contractor as detailed in IDPH Asbestos Regulation 855.330.

F. Contractor shall secure sample of label and retain as part of daily log/final report. Contractor shall label bags and/or containers for asbestos waste with the following information:

1. Generator Name
2. Project Location

G. The General Contractor and licensed Asbestos Contractor shall execute and provide to the EC the required Waste Shipment Record (WSR) for any asbestos waste generated during Work provided under this specification. WSR shall be signed by the generator, transporter and landfill. All WSRs shall be returned to the CHA within 30 days of transportation from the building.

H. Abatement Contractor shall submit to the EC current IDPH Asbestos Contractor license and accreditation and items listed in Section 855.350 (d). All documents shall be provided to the EC upon final acceptance of the work.

**END OF SECTION**

**SECTION 02 83 19.13**

**LEAD-BASED PAINT ABATEMENT**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings

1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. These specifications apply for all demolition, construction and renovation projects that require removal and disposal of lead-based paint in accordance with all applicable regulations.

1.3 INTRODUCTION

A. The Illinois Department of Public Health regulations apply to all facilities occupied by children 6 years old or younger. The Chicago Department of Public Health inspects for, and regulates, lead contamination in all CHA facilities. Abatement of all interior and exterior lead-bearing substances is covered by these specifications.

1.4 DEFINITIONS

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in this Section are incorporated by reference, whether or not restated herein.

B. Abatement Contractor (AC) means the entity responsible for performing the Work in this Section, with the training and accreditation to competently perform the work. This entity shall obtain and maintain any licenses required for the Work in this Section.

C. Architect means any person or firm employed by the CHA for the purpose of designing the project.

D. CDPH means the Chicago Department of Public Health.

E. Chicago Housing Authority (CHA) means the Owner of the property and the authority ordering the Work specified herein.

F. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

G. Contractor means the entity responsible for performing the complete scope of work in the Documents. The Contractor may elect to self-perform or subcontract out any portion of the work.

H. Competent person means one who is capable of identifying existing lead hazards in the workplace and selecting the appropriate control strategy for lead exposure, who has the authority to take prompt corrective measures to eliminate them, who is specially trained in a training course which meets the criteria of EPA's Model Accreditation Plan for supervisor, or its equivalent.

I. Drawings are those enumerated in the Schedule of Drawings, and additional drawings and sketches, if any, incorporated into the Contract by a bulletin issued by the Architect or Change Order as the Work progresses

J. Environmental Consultant (EC) means the entity with overall responsibility for the environmental aspects of the project, including design, organization, direction, oversight and control as well as investigations, assessments, and supervision of project manager.

K. HEPA Filter means a High Efficiency Particulate Air filter capable of trapping 99.97% percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.

L. IDPH means the Illinois Department of Public Health.

M. Lead Abatement Contractor/Supervisor, hereinafter referred to as “supervisor” means any person who supervises lead abatement workers. This person must be trained, accredited, and licensed as required, and must also meet OSHA “competent person” criteria for lead abatement.

N. Lead-Based Paint means paints or coatings that are lead bearing substances as defined by IDPH regulations referenced in Laws, Regulations and Standards specified elsewhere in the specifications.

O. Lead Bearing Soil means soil containing an amount of lead in excess of applicable guidelines.

P. Lead Bearing Substance means any dust on surfaces or furniture or other non-permanent items and any paint or other surface coating material as defined by IDPH regulations referenced in Laws, Regulations and Standards specified elsewhere in the specifications.

Q. OSHA means the federal Occupational Health and Safety Administration.

R. Plasticize means to apply plastic sheeting over surfaces or objects to protect them from contamination or water damage.

S. RCRA means the Resource Conservation and Recovery Act and associated regulations as referenced in Laws, Regulations and Standards specified elsewhere in the specifications.

T. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

U. TCLP means the Toxicity Characteristic Leaching Procedure as specified in EPA 530/SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods 3rd edition, November 1986

V. User or User Agency means the entity for which or on whose behalf the CHA has undertaken to cause the Work to be performed.

W. Wet Cleaning means cleaning all surfaces with a phosphate-free lead dissolving detergent.

X. Work means the obligations of the Contractor under the Contract Documents. Work includes, unless specifically excepted by the Contract Documents, the furnishing of all materials, labor, equipment, supplies, plant, tools, scaffolding, transportation, superintendence, permits, inspections, occupancy approvals, insurance, taxes, and all other services, facilities and expenses necessary for the full performance and completion of the requirements of the Contract Documents. Work also means that which is furnished, produced, constructed, or built pursuant to the Contract Documents.

Y. Work Area means areas where lead abatement activities are conducted.

Z. Work Site means the room or rooms undergoing lead abatement activities. All closets/book rooms/coat hanger rooms/vestibules/washrooms within a room are considered part of the Work Site in which abatement work has been identified on the Drawings, whether or not they are numbered separately.

1.5 WORK INCLUDED

A. The work includes all labor, equipment, materials, and supplies necessary to perform the Scope of Work in the bid documents by the procedures described herein. The contractor, by submitting a bid for the work, represents itself as knowledgeable and expert in the performance of the work, and includes all things usually and customarily necessary to provide a complete and finished job, whether specifically mentioned or not. Related work may be shown in other related documents.

B. Clean-up of lead-bearing dust, flakes, and residues; abatement of paint, architectural components, substrates, or other lead-bearing items listed in the Bid documents including pre-cleaning, moving of furnishings, establishing regulated areas, isolating the Work Areas, protection of adjacent surfaces, containment when required, cleanup and decontamination to the specified clearance levels, proper packaging and disposal of wastes, and all other steps necessary to complete the scope of work.

C. Repair or replacement of damaged surfaces, fixtures, or furnishings to restore them to their pre-existing condition to the satisfaction of CHA's Designated Representative, EC, and building engineer.

D. When the Bid documents include lead and asbestos abatement items in the same spaces, they should be performed in the sequence and combinations that produce the most efficient results and the least amount of total waste. That sequence will generally be:

1. Cleanup and removal of failed or delaminated friable asbestos-containing debris, if any.

2. Cleanup of lead dust, flakes, chips, and residues. If these lead wastes are mixed with asbestos debris, they must be disposed together as regulated lead waste or asbestos waste depending on TCLP results.
3. Removal of friable asbestos materials and cleanup of visible residues.
4. Removal of architectural components with lead-based paint still adhered, such as wood trim, doors, plaster, drywall, window frames, etc.
5. Removal of non-friable asbestos materials from the exterior. If both asbestos and lead are on the same components, for example lead paint and asbestos-containing glazing compound, the components may be removed and disposed as construction debris as long as both the lead- and asbestos-bearing materials remain intact.
6. Removal of lead-based paint, coatings, or surfacing material.
7. Final cleanup and decontamination of the workspace. Final air clearance (asbestos) and wipe samples (lead) may be performed concurrently.
8. When lead and asbestos work is combined, the more stringent regulations and procedures shall apply for both.
9. Waste disposal:

    a. Classified waste: loose paint flakes, chips, and dust; lead cleaning and decontamination supplies; combined final decontamination supplies; contaminated soil; disposable suits, gloves, head covers, and foot covers; respirator, vacuum, or negative air machine filters; or other items likely to fail a TCLP or RCRA test.
    b. Special waste: asbestos-containing waste materials and lead-contaminated waste that has passed TCLP or other RCRA tests.
    c. Construction and demolition (C&D) debris: lead-bearing architectural components; cleaned poly sheeting from lead projects; concrete and lumber without tile or mastic attached, demolition debris, and other general wastes.
    d. All asbestos-containing or lead-bearing wastes shall be disposed in a facility permitted to accept asbestos-containing or lead-bearing waste materials.

E. Compliance with all applicable laws, regulations, standards, and these specifications. In the case of a conflict, the contractor shall comply with the most stringent.

F. All licenses, accreditations, permits, notifications, reports, or other documents required by law, regulation, this specification, or the Bid documents.

## 1.6 LAWS, REGULATIONS, AND STANDARDS

A. CHA contractors shall maintain compliance with all applicable current laws, regulations, and standards including, but not limited to those listed below which are incorporated by reference:

1. 410 ILCS 45: Illinois Lead Poisoning Prevention Act
2. 7-4-110 & 7-4-120: Municipal Code of the City of Chicago
3. 77IAC845: Illinois Lead Poisoning Prevention Code (Revision 8/1/2000)
4. 29 CFR 1910: US OSHA General Industry Standards
5. 29 CFR 1926: US OSHA Construction Standards
6. HUD Guidelines: Lead Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing, except Chapter Seven (1995); Chapter 7 of the Guidelines, Lead Based Paint Inspection (Revised, 1997)

7. 40 CFR Part 61: US EPA National Emissions Standards for Hazardous Air Pollutants (NESHAP)
8. 40 CFR Part 261: Identification and Listing of Hazardous Waste (Resource Conservation and Recovery Act, RCRA)
9. 11-2-2190: Chicago Building Code- Sandblasting, grinding and chemical washing of buildings facilities or other structures; permit and notification requirements; performance standards for lead paint abatement, and disposal of debris.
10. 11-4-2170 Chicago Building Code- Demolition and Renovation Safeguards.
11. 40 CFR 245: Lead Renovation, Repair and Painting.

B. Regulatory changes shall be incorporated into this specification on their effective date. Contractors shall reflect these changes into ongoing projects without any additional notice or cost to CHA.

## 1.7 ASSESSMENT, MONITORING, TESTING, AND ANALYSIS

A. The EC will perform inspection, testing, and monitoring services during the work and upon its completion:

1. Testing of coatings, soils, dust, and debris to determine the presence of lead or other hazardous substances.
2. Area air monitoring during the work to determine the airborne concentrations of lead inside and outside of the Work Area. The EC shall stop the Work if airborne lead concentrations outside the Work Area exceed the OSHA Action Level of 30 micrograms per cubic meter of air (µg/m3) as an 8-hour time-weighted average. The Work may re-start when the source of lead release has been identified and resolved, and corrective measures have been instituted to prevent recurrence.

B. The Abatement Contractor shall perform:

1. An Exposure Assessment prior to the start of the Work to determine the requirements for respiratory protection and frequency of OSHA monitoring for each type of activity.
2. Perform OSHA compliance air monitoring to determine exposures to its employees in accordance with Laws, Regulations and Standards specified elsewhere in the specifications.

C. Credentials required for analysis of lead:

1. Accreditation by AIHA or AALA; or
2. Participation in the Environmental Lead Proficiency Analytical Testing (ELPAT) program or Environmental Lead Laboratory Accreditation Program (ELLAP); or
3. Participation in the Proficiency in Analytical Testing (PAT) for metals analysis.

## 1.8 SUBMITTALS

A. The Abatement Contractor (AC) shall submit the following information to the EPM:

1. Written notification to Illinois Department of Public Health.
2. Written Notification to CDPH.

3. Evidence that all contractor employees in the Work Areas are licensed, trained and accredited in accordance with OSHA, NESHAP, and EPA MAP requirements:

    a. Current refresher training certificate.
    b. Current IDPH lead license
    c. Current physician's written opinion
    d. Current respirator fit test data.

4. Copy of OSHA Exposure Assessment, if available.
5. OSHA compliance air monitoring records generated during the project.
6. Waste Shipment Records.
7. Worker license and certification log.
8. Safety Data Sheets (SDS) for chemicals used on site.
9. Work Plan and Schedule.
10. Laboratory or analyst credentials and proficiency certificates for contractor samples.

B. Prior to beginning Work, the AC shall submit required notifications to applicable regulatory agencies for buildings where lead abatement will take place. The AC shall provide copies of all regulatory notices to the CHA's Designated Representative and the EC within 24 hours of sending such notices to the regulatory authority. The AC shall not begin a project until such notices are provided to CHA.

1.9 RECORDKEEPING

A. AC shall retain records for 6 years:

1. Name and address of the contractor who performed the project.
2. Location of the project.
3. Summary of abatement techniques used.
4. Location of the disposal site for lead-based substances removed from the Work site.
5. Starting and completion dates of the lead abatement project.

**PART 2 - PRODUCTS**

2.1 TOOLS AND EQUIPMENT:

A. All equipment shall at least conform to minimum industry standards.

B. Equipment:

1. Negative Air Machines shall provide HEPA filtration and conform to ANSI Z9.2 fabrication criteria.
2. The AC should ensure that respirators are NIOSH approved for use with lead, asbestos, or other contaminants anticipated in the Work.
3. Contractor is fully responsible for complying with OSHA rules for other Safety equipment, such as hard hats, safety harnesses, eye protection, gloves, footwear, and any other safety devices used on the site.

C. Tools:

1. Shovels and scoops shall be suitable for use in a plasticized containment. Plastic or rubber models are preferred, but metal shovels are acceptable when used with care to prevent damage to poly sheeting and permanent surfaces. Appropriate tape may be applied to the leading edges to aid in poly damage prevention.
2. Scrapers, wire and bristle brushes, utility knives and other hand tools shall be of good quality and suitable for the intended uses. The contractor shall keep an ample supply on hand for the completion of the Work.
3. Power tools such as, but not limited to saws, pneumatic chisels, brushes, sanders, and needle guns shall be equipped with shrouds and HEPA-filtered local exhaust systems to capture released particles.

2.2 MATERIALS

A. Installed materials which become a part of the Work such as, but not limited to, primers, paints, surfacing compounds, and other surface coverings or finishes shall be new unless specified otherwise, of good quality, non-lead-bearing, and shall conform to the respective reinstallation specification sections.

B. Abatement materials:

1. Poly sheeting for all applications shall be 6 mil nominal thickness for all applications.
2. Tape shall be 2" or 3" tape suitable for joining poly seams and attaching poly sheeting to surfaces.
3. Spray adhesives shall be non-flammable and free of methylene chloride solvents.
4. Chemicals used for LBP removal and cleanup shall be free of methylene chloride solvents. The chemicals shall be low-odor and free of volatile compounds.
5. Disposal bags shall be 6 mil where used for single-bagging, and minimum 4 mil where used for double-bagging.
6. Disposable suits, hoods, and foot coverings shall be TYVEK or similar.
7. Solvents shall be compatible with any primers, paints, coatings, or other surfacing materials to be installed following their use.
8. Cleaning solutions shall cause lead to chelate, precipitate, or otherwise effectively release lead from surfaces. Cleaning solutions shall not leave residue on surfaces to be painted.

**PART 3 - EXECUTION**

3.1 EMPLOYEE TRAINING, QUALIFICATION AND MEDICAL SCREENING

A. Supervisors and workers shall be trained, accredited, and licensed in accordance with IDPH rules.

1. Contractor shall keep current, up-to-date copies of licenses at the job site at all times.
2. A licensed supervisor (competent person) shall be present at the Work site at all times when Work under this Section is being conducted.

B. Medical Screening shall be instituted for contractor's employees in accordance with regulations referenced in Laws, Regulations and Standards specified elsewhere in the specifications. Medical certificates shall be current.

## 3.2 PERMISSIBLE LIMITS

A. Permissible Limits of lead in lead bearing substances. Substances with lead content below the following levels are not regulated and are not subject to the requirements of this Section:

1. 5,000 parts per million (ppm), or 0.5% lead by weight in any substance. However, note that OSHA regulations apply to any operation that releases lead into the air in concentrations in excess of the action level of 30 µg/m3 (see Permissible Exposure Limits for contractor employees below), and the CDPH shall require remedial action when dust contains greater than 40 µg/sf (see sub-paragraph below) of surface area. Actions such as sandblasting, dry sanding, or other dry aggressive abrasive disturbances can generate lead concentrations greater than either of these limits on substances with lower lead contents and, in such instances, shall be required to adhere to this specification, regardless of substance lead content.
2. 400 micrograms per gram (µg/g) of soil in high contact play areas.
3. 400 micrograms per gram (µg/g) of soil in other areas.
4. 40 micrograms per square foot (µg/sf) of surface area of dust on interior floors.
5. 200 micrograms per square foot (µg/sf) of surface area of dust on other surfaces.

B. Permissible Exposure Limits for contractor employees:

1. No person shall be exposed to a lead concentration in excess the regulations referenced in Laws, Regulations and Standards specified elsewhere in the specifications.
2. Where exposures exceed regulated levels, medical monitoring shall be instituted by the AC in accordance with the regulations referenced in Laws, Regulations and Standards specified elsewhere in the specifications.

## 3.3 EXPOSURE ASSESSMENT AND MONITORING

A. The AC shall make an assessment of the exposures expected by the tasks to be used for the scope of work listed in the Bid documents. Assessment may be based upon:

1. Initial monitoring of representative workers who the contractor believes are exposed to the greatest airborne concentrations of lead, or
2. Past monitoring (within the past 12 months) or objective data for conditions closely resembling the processes, type of material, control methods, Work practices and environmental conditions to be used for this document, or
3. In the absence of an exposure assessment or monitoring, the contractor shall assume the following exposure conditions:

   a. ≤ 400 µg/m3 for manual demolition of lead-bearing substances (i.e., drywall, other architectural components), manual scraping, manual sanding, heat gun use, and power tool cleaning with dust collection systems, or any other task where there is reason to believe an employee may be exposed to airborne lead.

b. ≤ 2,500 µg/m3 for lead burning, rivet busting, power tool cleaning without dust collection systems, cleanup of dry spent abrasives, or movement or removal of abrasive blasting enclosures.
c. > 2,500 µg/m3 for abrasive blasting, welding, cutting, and torch burning.

B. The contractor shall perform personal monitoring in accordance with the regulations referenced in Laws, Regulations and Standards specified elsewhere in the specifications.

C. The contractor may be required to perform air monitoring outside the Work Area if there is observance of contamination escape from the Work Area (such as dust accumulation), or evidence of failure of control methods to contain the release of airborne lead particles.

## 3.4 RESPIRATORY PROTECTION

A. Respiratory protection shall be worn in accordance with all applicable regulations referenced in Laws, Regulations and Standards specified elsewhere in the specifications.

## 3.5 HYGIENE PRACTICES

A. Eating, drinking, smoking, and applying of cosmetics are not allowed in the Work site or area.

B. A changing area and shower shall be provided for changing into and removing personal protective clothing and for showering or washing before leaving the Work Area. Any person leaving the Work site or Work Area shall rinse his or her mouth with potable water and wash hands and face thoroughly before eating drinking, or smoking. A portable lavatory facility, potable water supply, or portable decontamination unit shall be provided by the contractor for the washing of face and hands before any abatement activities are started. CHA lavatory facilities shall not be used.

C. Equipment decontamination procedures shall be employed to prevent the spread of lead contamination. Disposable items shall not be reused and shall be disposed of properly.

D. Personal Protection Equipment (PPE) shall include:

1. Full body suits with hoods and shoe covers. Tyvek or similar disposable suits may be worn only once, and must be disposed in accordance with the Waste Disposal Article in the specifications.
2. Appropriate PPE shall be used as required by regulations referenced in Laws, Regulations and Standards specified elsewhere in this Section and established industry practice.

## 3.6 PROHIBITED ACTIVITIES

A. The following methods shall not be permitted:

1. open flame burning
2. dry-sanding
3. uncontained hydro-blasting or sandblasting

4. use of methylene chloride
5. dry-scraping

## 3.7 WORK AREA ISOLATION AND PREPARATION

A. General Preparation

1. Post caution signs at all entrances and exits to the Work Area in accordance with OSHA rules:

    a. at least 20" x 14"
    b. date and location of the lead abatement project
    c. Wording at least 2" high stating, "Caution, Lead Hazard, Do Not Remain in Work Area Unless Authorized"

2. Secure the Work Area from entry by children, pregnant women, staff or other unauthorized persons.
3. Close off the Work Site from other portions of the building by closing doors tightly, taping shut when necessary, or with 6 mil poly z-flap curtains over doorways or entrances to the Work Site.
4. At Work Area exit, provide walk-off pan, wet towel, or other means to prevent tracking lead contamination to other parts of the facility. A protective liner that is watertight shall be placed under the walk-off pan, wet towel, to prevent damage to the underlying surface.

B. Interior Preparation

1. Furniture, personal items, and other moveable objects in the Work Site shall be protected with 6 mil poly sheeting and sealed with tape, or moved from the Work Site and stored in a location designated by the EC. Items shall be cleaned before being moved to another area to prevent cross-contamination.
2. Turn off all forced air ventilation and seal exhaust and intake points in the Work Site.
3. Turn off electrical circuits in the Work Area to isolate them from contact. Provide temporary power equipped with Ground-Fault Circuit Interrupter (GFCI) devices to prevent electric hazards in the wet working environments. Power cords must be in good condition, not spliced, not more than 100 feet long, and shall be suspended off the floor and out of workers' way to protect the cords from damage. Cords must not be fastened with staples, hung from nails, or suspended with wire.
4. Seal the opening seams of all food storage units, such as cabinets or refrigerators, or cover with poly sheeting taped securely in place.
5. Cover all objects that cannot be moved, such as radiators, stoves, cabinets, built-in furniture, bookcases, or other stationary items with 6 mil plastic sheeting taped securely in place.
6. If required by the scope of work, remove all carpeting from the Work Site. Lightly mist with water prior to removal to prevent lead dust exposure. Carpeting shall be professionally cleaned or replaced, if required by scope of work.
7. Cover and protect floors in the Work Site with 6 mil plastic sheeting, sealed with tape. Additional protection may be required to protect flooring materials from potential damages resulting from the /abatement processes. All additional protection shall be provided as needed to ensure that all building surfaces will be adequately protected during the mitigation/abatement processes and be included in the base bid.

8. Establish a negative pressure system to prevent contaminated air from escaping from the Work Site to uncontaminated areas, and consisting of:

    a. Negative air machines (NAMs) exhausted from the Work Site, and vented to the outside of the building whenever possible.
    b. Provide sufficient number of NAMs to provide a negative pressure of 0.02" wc between the Work Area and adjacent spaces, and 4 air changes per hour. Assume NAMs operate at 80% of design capacity. At least one backup NAM shall be available per Work Site.
    c. The negative air system shall remain in continuous operation until cleanup and clearance is achieved.

C. Exterior Preparation

1. 6 mil plastic sheeting shall be placed over the ground, foundation, or other surfaces adjacent to or below the abatement area.
2. Close or otherwise seal windows, grilles, intakes, or other nearby openings (above, below, or beside) that could be exposed to airborne dust from the work.
3. Sheeting shall extend out from the foundation 3 feet per story to be abated, with a minimum of 5 feet and a maximum of 20 feet. This sheeting shall remain in place until completion of final cleaning.
4. Sheeting shall be secured at the foundation and along all edges and seams.
5. When liquid waste is produced by any abatement method used, the edges of the plastic sheeting shall be raised a sufficient distance to contain the liquid waste.

## 3.8 LEAD ABATEMENT

A. General:

1. Unless otherwise specified in the Bid documents, lead-bearing substances listed in the Bid documents shall be removed by methods that minimize the generation of dust or debris.
2. Lead-based paint abatement practices shall be compatible with and shall produce surfaces that are in conformance with Division 09.
3. Where existing lead-bearing substances may be disturbed by the installation of new work, they shall be removed sufficiently to prevent such disturbances.
4. Following any window dismantlement activity in the Work Area, the abatement contractor shall wet scrape the loose paint off the exposed window lintel and prepare, seal, prime and paint the lintel surface. If the lintel is to be replaced as required by the Architect, the abatement contractor shall only remove all the loose paint and not repaint the lintel surface.
5. Where disturbances of lead-bearing substances produce dust, the dust must be assumed to contain lead until tested and proven otherwise. Dust suppression methods, such as misting with water and HEPA vacuums shall be used.
6. Movement of lead-bearing wastes through unsecured CHA areas:

    a. Wastes shall be contained in 6 mil impermeable (i.e. poly) bags.
    b. Architectural components and other debris shall be wrapped in 6 mil plastic sheeting and sealed with tape.
    c. Load-out only during non-school hours.

d. Dust and debris shall not be tracked or spilled outside the Work Site. In the event of spillage or tracking, contractor shall HEPA vacuum visible debris and wet wipe all affected areas with a non-TSP lead-dissolving detergent solution.

B. Interior Abatement methods may include:

1. Removal and replacement of the component or surface.
2. Wet scraping of lead-bearing material.
3. Heat gun with operating temperatures not to exceed 700˚ F.
4. Nonflammable chemical strippers shall not contain methylene chloride. This method is generally used with unique, irreplaceable, architecturally, or historically significant components. Chemical strippers shall be compatible with new paints, coverings, or coatings to be installed.
5. Sander, needle gun, chipper, scarifier, or other mechanical paint removal system. All such power tools shall be equipped with a HEPA vacuum collection system.
6. Enclosure with a durable material or coating that does not readily tear or peel, such as but not limited to, gypsum board; fiberglass mats; canvas-backed vinyl wall coverings; high pressure, laminated plastic sheet, such as Formica®, tile, vinyl flooring, paneling, plastic, metal, or wood. Enclosures shall only be used when specified in the Bid documents.

C. Exterior abatement methods may include:

1. All methods listed under Interior Abatement.
2. Vacuum-blasting.
3. Contained hydro-blasting or sandblasting.
4. When vacuum-blasting or contained hydro-blasting is used, window interiors shall be sealed with 6 mil plastic sheeting and secured with waterproof tape. All seals shall be checked every two (2) hours to assure integrity. Leaks shall be repaired immediately.
5. Window replacement:

a. The room interior shall be sealed off and protected from dust entry. If windows are removed from the inside, the room must be fully protected in accordance with Work Area Isolation and Preparation “Interior Preparation” and “Exterior Preparation” specified elsewhere in Part 3. When windows are removed from the outside, protection must be in accordance Work Area Isolation and Preparation “Exterior Preparation” specified elsewhere in Part 3, including at least a seal over the wall immediately inside the window Work Area. In either case, the AC is responsible for preventing lead dust contamination of interior spaces.
b. Damaged lead-based paint must be removed from the wood window frame parts that will remain, both on the inside and on the outside. EC will direct the AC whether to abate or mitigate undamaged lead-based paint from wood window frames or frame parts on a case by case basis.
c. Metal window replacements: The contractor is cautioned that high concentrations of lead dust and asbestos containing caulk have been found behind the window frame caps installed over the original lead-based painted frames during previous window replacements. Although a lead license is not required for non-LBP metal window removal, contractor must assume that he or she may encounter concentrated lead dust. When removing these caps, the room interior shall be protected in accordance with Work Area Isolation and Preparation “Interior Preparation” specified elsewhere in Part 3.

D. Soil Removal or Remediation:

1. Identify and eliminate the source of lead contamination if possible, to prevent re-contamination of remediated soil.
2. Dust generation shall be held to a minimum and dust suppression methods shall be performed, such as misting with water during handling.
3. Monitoring of airborne dust shall be performed by the EC and shall not exceed acceptable levels.
4. Soil that is stockpiled prior to disposal shall be:

    a. placed on a layer of impermeable plastic;
    b. kept moist to avoid dust generation; and
    c. covered with impermeable plastic which is secured to the ground.

5. Soil shall be subjected to a TCLP test to determine waste classification.
6. Contaminated soil shall be transported to disposal facility in sealed containers or covered vehicles. Care shall be taken to prevent tracking of contaminated soil off-site by vehicular or foot traffic.

E. Demolition. Structural demolition of buildings does not require removal of lead-bearing substances or lead-licensed contractors or workers. However, the following minimum requirements must be observed to prevent spread of lead contamination:

1. Close windows and seal doors of adjacent or nearby structures. Cover air intakes or other openings on facing walls or roof areas where dust could enter.
2. Mist the demolition activities with water to suppress dust release.
3. Remove and dispose of loose lead-based paint from substrate prior to demolition. Conduct waste characterization for proper disposal.
4. Remove and dispose of loose lead-based paint form floors and horizontal surfaces. Conduct waste characterization for proper disposal.
5. Do not spread debris outside the immediate demolition area.
6. Do not allow foot or other traffic through the demolition area that may spread lead-bearing dust to other building areas.
7. Pulverized painted components may generate lead dust that may require TCLP testing and waste characterization prior to disposal.

## 3.9 CLEANING AND DECONTAMINATION

A. Interior Cleaning: includes any furniture, cabinets, or other item that was located in the Work Area during the lead-based paint /abatement activities.

1. Properly containerize and remove all lead wastes from the Work Site.
2. HEPA vacuum all surfaces including woodwork, walls, windows, window wells, and floors.
3. Wet clean all surfaces with a cleaning solution.
4. Allow all surfaces to dry and HEPA vacuum any remaining visible residue.

B. Exterior Cleaning:

1. Recover all visible debris from exterior areas.

2. HEPA vacuum surfaces that have been abated, paying particular attention to horizontal surfaces, such as windowsills, wells, mullions, ledges, etc., both in the abated area and on nearby windows and surfaces.

3.10 FINAL CLEARANCE

A. A lead abatement Work Area shall be complete if lead dust levels on horizontal interior surfaces are below 10 micrograms per square foot (µg/sf) on floors or 100 micrograms per square foot (µg/sf) on other surfaces by the EC. At least 3 wipe samples per contained Work Area shall be collected by the EC from floors, windowsills, countertops, tops of cabinets, or other representative surfaces.

B. The contractor shall restore the Work Area to usable condition including reconnection of electrical, water and HVAC services, removal of barriers and contractor equipment, waste removal and disposal and returning furniture removed as required by Work Area Isolation and Preparation specified elsewhere in Part 3.

3.11 WASTE DISPOSAL

A. All plaster, paint chips, lead dust, cleaning supplies, HEPA filters, vacuum contents and filters, disposable suits, and other concentrated lead-bearing waste shall be packed in at least two 6 mil plastic bags.

1. Dispose of concentrated lead wastes separately from architectural components.
2. Subject concentrated wastes to TCLP test to determine waste classification.
3. Prepare a Waste Shipment Record, to be signed by the generator, shipper, and disposal site; to be returned to the generator within 45 days. IEPA and USEPA Generator I.D. numbers shall be provided by CHA.

B. Architectural components, other items to which lead-based paint remains adhered and cleaned plastic sheeting may be disposed of as common construction and demolition debris. Components shall be wrapped in 6 mil plastic sheeting and sealed with tape. Components shall be transported after school hours if carried through the building.

C. All lead-bearing wastes shall be stored in covered, locked containers until transported off-site.

D. Remove lead waste from the Work Site in accordance with RCRA and special waste disposal requirements.

E. Transport all non-hazardous wastes in covered vehicles to an IEPA-approved landfill.

F. Transport all hazardous wastes in covered vehicles to a hazardous waste landfill permitted to accept lead wastes.

G. Wastes from the site shall not be mixed with wastes from other sites.

**END OF SECTION**

**SECTION 02 83 20**

**MINOR DISTURBANCE OF PAINTED SURFACES ASSUMED TO CONTAIN LEAD**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Contract drawings.

### 1.2 APPLICABILITY

A. These environmental requirements apply to all CHA projects. These specifications apply for all demolition, construction and renovation projects that require the minor disturbance of any painted surface that is assumed to contain lead in accordance with all applicable regulations.

### 1.3 INTRODUCTION

A. Lead Safe Work Practices are required to maintain a healthful learning environment for students, maintain good public relations with neighbors and employees, prevent damage, minimize cleaning and maintenance costs, and to comply with regulations and laws. All contractors (including subcontractors, lower-tier subcontractors, and suppliers) who perform work or provide services at Chicago Housing Authority (CHA) facilities are required to utilize Lead Safe Work Practices during their operations and/or activities.

B. This Section applies to any disturbances of painted surfaces assumed to contain lead as defined in this section. Disturbances of any quantity of paint known to be Lead-Based Paint is not covered by this section.

### 1.4 DEFINITIONS

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in this Section are incorporated by reference, whether or not restated herein.

B. Architect means the entity that assembles the overall documents and bid package and approves the completed work.

C. Certified Renovator means an individual that is certified by the United States Environmental Protection Agency's (USEPA) Renovation, Repair and Painting program (40 CFR 745).

D. CDPH means the Chicago Department of Public Health.

E. Chicago Housing Authority (CHA) means the Owner of the property and the authority ordering the work specified herein.

F. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

G. Contractor means the entity responsible for performing the complete scope of work in the Documents. The Contractor may elect to self-perform or subcontract out any portion of the work.

H. Environmental Consultant (EC) is the entity contracted by the CHA to prepare environmental designs, conducts oversight and testing, and reviews the environmental work, submittals, and reports for all work which requires removal or disturbance of materials requiring special handling, removal and disposal.

I. HEPA Filter means a High Efficiency Particulate Air filter capable of trapping 99.97% percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.

J. IDPH means the Illinois Department of Public Health.

K. Plasticize means to apply plastic sheeting over surfaces or objects to protect them from contamination or water damage.

L. Personal Protective Equipment (PPE) means the protective suits, head and foot covers, gloves, respirators and other items used to protect persons from potential hazards.

M. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

N. Work Area means the area or areas where work is being conducted.

1.5 WORK INCLUDED

A. The work includes all labor, equipment, materials, and supplies necessary to perform the Scope of Work in the Documents by the procedures described herein. The Contractor, by submitting a bid for the work, represents itself as knowledgeable and expert in the performance of the work, and includes all things usually and customarily necessary to provide a complete and finished job, whether specifically mentioned or not. Related work may be shown in other related documents prepared by others.

B. Repair or replacement of damaged surfaces, fixtures, or furnishings to restore them to their pre-existing condition to the satisfaction of CHA's Designated Representative, EC and building engineer.

C. Compliance with all applicable laws, regulations, standards, and these specifications. In the case of a conflict, the Contractor shall comply with the most stringent.

D. All licenses, accreditations, permits, notifications, reports, or other documents required by law, regulation, this specification, or the Documents.

E. No visible emissions or unreasonable odors shall be permitted outside the work area.

F. All products to be used at CHA facilities that could potentially emit dusts, fumes, vapors or odors, etc. shall be submitted to CHA's Designated Representative with accompanying SDS for approval prior to the use of the product.

1.6 LAWS, REGULATIONS, AND STANDARDS.

A. The Contractor is responsible for compliance with all applicable federal, state, county and municipal laws, regulations and ordinances including, but not limited to, those listed below, which are incorporated by reference.

B. The following laws, regulations and standards are incorporated by reference:

1. 29 CFR 1910: US OSHA General Industry Standards.
2. 29 CFR 1926: US OSHA Construction Standards.
3. 40 CFR Part 61: USEPA National Emissions Standards for Hazardous Air Pollutants (NESHAP).
4. 40 CFR 745: Lead Renovation, Repair and Painting Program.
5. 11-4-2170: Chicago Building Code- Demolition and renovation safeguards.
6. 11-4-2190: Chicago Building Code: Sandblasting, grinding and chemical washing of buildings, facilities or other structures - Dust minimization--Containment, wetting or vacuuming; plan required.

C. Contractor shall follow procedures outlined in this specification for all work which requires the disturbance of painted surfaces assumed to contain lead. If contract work requires disturbance of any amount of known lead-based paint, Contractor shall perform work in accordance with Specification Section 02 83 19.13

**PART 2 - PRODUCTS**

2.1 Tools and Equipment:

A. All equipment shall at least conform to minimum industry standards.

B. Equipment:

1. Negative Air Machines shall provide HEPA filtration and conform to ANSI Z9.2 fabrication criteria.
2. The Contractor should ensure that respirators are NIOSH approved for use with lead, asbestos, or other contaminants anticipated in the work.
3. Contractor is fully responsible for complying with OSHA rules for other Safety equipment, such as hard hats, safety harnesses, eye protection, gloves, footwear, and any other safety devices used on the site.

C. Tools:

1. Shovels and scoops shall be suitable for use in a plasticized containment. Plastic or rubber models are preferred, but metal shovels are acceptable when used with care to

prevent damage to poly sheeting and permanent surfaces. Appropriate tape may be applied to the leading edges to aid in poly damage prevention.

2. Scrapers, wire and bristle brushes, utility knives and other hand tools shall be of good quality and suitable for the intended uses. The Contractor shall keep an ample supply on hand for the completion of the work.
3. Power tools such as, but not limited to saws, pneumatic chisels, brushes, sanders, and needle guns shall be equipped with shrouds and HEPA-filtered local exhaust systems to capture released particles.

2.2 Materials

A. Installed materials which become a part of the work such as, but not limited to, primers, paints, surfacing compounds, and other surface coverings or finishes shall be new unless specified otherwise, of good quality, non-lead-bearing, and shall conform to the respective reinstallation specification sections.

B. Abatement materials

1. Fire-retardant poly sheeting for all applications shall be 6 mil nominal thickness for all applications.
2. Tape shall be 2" or 3" tape suitable for joining poly seams and attaching poly sheeting to surfaces.
3. Spray adhesives shall be non-flammable and free of methylene chloride solvents.
4. Chemicals used for LBP removal and cleanup shall be free of methylene chloride solvents. The chemicals shall be low-odor and free of volatile compounds.
5. Disposal bags shall be 6 mil where used for single-bagging, and minimum 4 mil where used for double-bagging.
6. Disposable suits, hoods, and foot coverings shall be TYVEK or similar.
7. Solvents shall be compatible with any primers, paints, coatings, or other surfacing materials to be installed following their use.
8. Cleaning solutions shall cause lead to chelate, precipitate, or otherwise effectively release lead from surfaces. Cleaning solutions shall not leave residue on surfaces to be painted.

**PART 3 - EXECUTION**

3.1 STANDARDS FOR WORK ACTIVITIES

A. *General.* Work activities covered by this section must be performed by certified firms using certified renovators as directed in 40 CFR 745.89. The responsibilities of certified firms are set forth in 40 CFR 745.89(d) and the responsibilities of certified renovators are set forth in 40 CFR 745.90(b).

B. *Occupant protection.* Contractor must post signs clearly defining the work area and warning occupants and other persons not involved in the work activities to remain outside of the work area. To the extent practicable, these signs must be in the primary language of the occupants. These signs must be posted before beginning the work and must remain in place and readable until the work and the post-work clearance wipe sampling has been completed. If warning signs

have been posted in accordance with 24 CFR 35.1345(b)(2) or 29 CFR 1926.62(m), additional signs are not required by this section.

C. *Containing the work area.* Before beginning the work, the Contractor must isolate the work area so that no dust or debris leaves the work area while the work is being performed. In addition, the Contractor must maintain the integrity of the containment by ensuring that any plastic or other impermeable materials are not torn or displaced and taking any other steps necessary to ensure that no dust or debris leaves the work area while the work is being performed. The Contractor must also ensure that containment is installed in such a manner that it does not interfere with occupant and worker egress in an emergency.

3.2 INTERIOR WORK.

A. Remove all objects from the work area, including furniture, rugs, and window coverings, or cover them with plastic sheeting or other impermeable material with all seams and edges taped or otherwise sealed.

B. Close and cover all ducts opening in the work area with taped-down plastic sheeting or other impermeable material.

C. Close windows and doors in the work area. Doors must be covered with plastic sheeting or other impermeable material. Doors used as an entrance to the work area must be covered with plastic sheeting or other impermeable material in a manner that allows workers to pass through while confining dust and debris to the work area.

D. Cover the floor surface, including installed carpet, with taped-down plastic sheeting or other impermeable material in the work area 6 feet beyond the perimeter of surfaces being worked on, or a sufficient distance to contain the dust, whichever is greater. Floor containment measures may stop at the edge of the vertical barrier when using a vertical containment system consisting of impermeable barriers that extend from the floor to the ceiling and are tightly sealed at joints with the floor, ceiling and walls.

E. Use precautions to ensure that all personnel, tools, and other items, including the exteriors of containers of waste, are free of dust and debris before leaving the work area.

3.3 EXTERIOR WORK.

A. Close all doors and windows within 20 feet of the work. On multi-story buildings, close all doors and windows within 20 feet of the work on the same floor as the work, and close all doors and windows on all floors below that are the same horizontal distance from the work.

B. Ensure that doors within the work area that will be used while the job is being performed are covered with plastic sheeting or other impermeable material in a manner that allows workers to pass through while confining dust and debris to the work area.

C. Cover the ground with plastic sheeting or other disposable impermeable material extending 10 feet beyond the perimeter of surfaces being worked on or a sufficient distance to collect falling paint debris, whichever is greater, unless the property line prevents 10 feet of such ground

covering. Ground containment measures may stop at the edge of the vertical barrier when using a vertical containment system.

D. If the work will affect surfaces within 10 feet of the property line, the Contractor must erect vertical containment or equivalent extra precautions in containing the work area to ensure that dust and debris from the work does not contaminate adjacent buildings or migrate to adjacent properties. Vertical containment or equivalent extra precautions in containing the work area may also be necessary in other situations in order to prevent contamination of other buildings, other areas of the property, or adjacent buildings or properties.

## 3.4 PROBHITED AND RESTRICTED WORK PRACTICES

A. The work practices listed below are prohibited or restricted as follows:

1. Open-flame burning or torching of painted surfaces is prohibited.
2. The use of machines designed to remove paint or other surface coatings through high speed operation such as sanding, grinding, power planing, needle gun, abrasive blasting, or sandblasting, is prohibited on painted surfaces unless such machines have shrouds or containment systems and are equipped with a HEPA vacuum attachment to collect dust and debris at the point of generation. Machines must be operated so that no visible dust or release of air occurs outside the shroud or containment system.
3. Operating a heat gun on painted surfaces is permitted only at temperatures below 1,100 degrees Fahrenheit.

## 3.5 WASTE HANDLING AND MANAGEMENT PRACTICES

A. Waste from work activities must be contained to prevent releases of dust and debris before the waste is removed from the work area for storage or disposal. If a chute is used to remove waste from the work area, it must be covered.

B. At the conclusion of each work day and at the conclusion of the work, waste that has been collected from work activities must be stored under containment, in an enclosure, or behind a barrier that prevents release of dust and debris out of the work area and prevents access to dust and debris.

C. When the Contractor transports waste from work activities, the Contractor must contain the waste to prevent release of dust and debris.

D. Contractor shall dispose of all wastes in accordance with all applicable regulations.

## 3.6 CLEANING THE WORK AREA

A. After the work has been completed, the Contractor must clean the work area until no dust, debris or residue remains.

1. Interior and exterior works. The Contractor must collect all paint chips and debris and, without dispersing any of it, seal this material in a heavy-duty bag.

2. Remove the protective sheeting. Mist the sheeting before folding it, fold the dirty side inward, and either tape shut to seal or seal in heavy-duty bags. Sheeting used to isolate contaminated rooms from non-contaminated rooms must remain in place until after the cleaning and removal of other sheeting. Dispose of the sheeting as waste.

B. *Additional cleaning for interior works.* The Contractor must clean all objects and surfaces in the work area and within 2 feet of the work area in the following manner, cleaning from higher to lower:

1. *Walls.* Clean walls starting at the ceiling and working down to the floor by either vacuuming with a HEPA vacuum or wiping with a damp cloth.
2. *Remaining surfaces.* Thoroughly vacuum all remaining surfaces and objects in the work area, including furniture and fixtures, with a HEPA vacuum. The HEPA vacuum must be equipped with a beater bar when vacuuming carpets and rugs.
3. Wipe all remaining surfaces and objects in the work area, except for carpeted or upholstered surfaces, with a damp cloth. Mop uncarpeted floors thoroughly, using a mopping method that keeps the wash water separate from the rinse water, such as the 2-bucket mopping method, or using a wet mopping system.

## 3.7 STANDARDS FOR POST WORK CLEANING VERIFICATION

A. *Interiors*. The Contractor must perform a visual inspection to determine whether dust, debris or residue is still present. If dust, debris or residue is present, these conditions must be removed by re-cleaning and another visual inspection must be performed. After a successful visual inspection the Contractor must:

1. Verify that each windowsill in the work area has been adequately cleaned, using the following procedure.

   a. Wipe the windowsill with a wet disposable cleaning cloth that is damp to the touch. If the cloth matches or is lighter than the cleaning verification card, the windowsill has been adequately cleaned.
   b. If the cloth does not match and is darker than the cleaning verification card, re-clean the windowsill as directed in paragraphs (a)(5)(ii)(B) and (a)(5)(ii)(C) of this section, then either use a new cloth or fold the used cloth in such a way that an unused surface is exposed, and wipe the surface again. If the cloth matches or is lighter than the cleaning verification card, that windowsill has passed the cleaning verification.
   c. If the cloth does not match and is darker than the cleaning verification card, repeat the procedures in paragraph (c) until cloth matches of is lighter than the cleaning verification card.

2. Verify that all uncarpeted floors and other horizontal surfaces have been adequately cleaned using the following procedure:

   a. Wipe uncarpeted floors and other horizontal surfaces within the work area with a wet disposable cleaning cloth. Floors must be wiped using an application device with a long handle and a head to which the cloth is attached. The cloth must remain damp at all times while it is being used to wipe the surface for post-work cleaning verification. If the surface within the work area is greater than 40 square

feet, the surface within the work area must be divided into roughly equal sections that are each less than 40 square feet. Wipe each such section separately with a new wet disposable cleaning cloth. If the cloth used to wipe each section of the surface within the work area matches the cleaning verification card, the surface has passed the cleaning verification.

b. If the cloth used to wipe a particular surface section does not match the cleaning verification card, re-clean that section of the surface as directed in paragraphs (a)(5)(ii)(B) and (a)(5)(ii)(C) of this section, then use a new wet disposable cleaning cloth to wipe that section again. If the cloth matches the cleaning verification card, that section of the surface has passed the cleaning verification.

c. If the cloth used to wipe a particular surface section does not match the cleaning verification card after the surface has been re-cleaned, repeat the procedures in paragraph (e) until cloth matches or is lighter than the cleaning verification card.

d. When the work area passes all post cleaning verifications the Contractor shall notify the EC that the area is ready for clearance wipe sampling. Contractor shall notify EC at least 24 hours in advance for all clearance wipe inspections.

3. Clearance Wipe Sampling

a. The EC shall conduct clearance wipe sampling in twenty percent (20%) of the work areas. The number of work areas tested shall be based on the total number of work areas anticipated for the entire project and shall be selected randomly from the areas available for testing.

b. Turnaround times for laboratory results for clearance wipe samples shall be 24 hours. Costs of expedited results shall be borne by the Contractor.

c. A work area shall be complete if lead dust levels on horizontal interior surfaces are below 40 micrograms per square foot (µg/sf) on floors or 200 micrograms per square foot (µg/sf) on other surfaces. 3 wipe samples per contained work area shall be collected from floors, windowsills, countertops, tops of cabinets, or other representative surfaces.

d. The contractor shall re-clean and repeat the post cleaning verification procedure in all work areas that fail to meet the clearance criteria. The contractor shall notify the EC when the re-cleaned areas have passed all post cleaning verifications.

e. The EC shall re-test only those work areas which have been re-cleaned.

f. The contractor shall restore the work area to usable condition including reconnection of electrical, water and HVAC services, removal of barriers and contractor equipment, waste removal and disposal and returning furniture removed as required as specified elsewhere in Part 3.

B. *Exteriors.* A certified renovator must perform a visual inspection to determine whether dust, debris or residue is still present on surfaces in and below the work area, including windowsills and the ground. If dust, debris or residue is present, these conditions must be eliminated and another visual inspection must be performed.

1. When all surfaces in the area pass the visual inspection, the Contractor shall notify the EC that the area is ready for final visual inspection.

C. *Activities conducted after post-work clearance wipe sampling.* Activities that do not disturb paint, such as applying paint to walls that have already been prepared, are not regulated by this subpart if they are conducted after post-work clearance wipe sampling has been performed.

3.8 CONTAMINATION OF AREAS OUTSIDE OF WORK AREAS

A. In the event that dust or fumes escape from the work area or create dirty conditions or contamination to nearby building spaces or grounds, the Contractor is responsible for all costs associated with the cleaning, testing and/ or repair deemed necessary by CHA's Designated Representative.

**END OF SECTION**

**SECTION 02 86 13**

**HAZARDOUS AND UNIVERSAL WASTE MANAGEMENT**

## PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings

1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. These specifications apply for all demolition, construction and renovation projects that require the removal and disposal of hazardous and/or universal waste in accordance with all applicable regulations.

1.3 INTRODUCTION

A. This Section describes the segregation, packaging, labeling, transport, and disposal and/or recycling of hazardous and universal waste materials generated by demolition/renovation activities and the subsequent shipment of properly packaged and labeled waste materials to open, permitted and CHA-approved disposal sites.

B. The Contractor's Work includes work area preparation, sampling and analysis, on-site handling, supervision of all Work, preparation of reports, protection of on-site persons, utilities, and property, and payment of all transport and disposal/recycling fees.

1.4 DEFINITIONS

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in the specifications are incorporated by reference, whether or not restated herein.

B. Capacitor means device for accumulating and holding a charge of electricity and consisting of conducting surfaces separated by dielectric fluid.

C. CFR means the Code of Federal Regulations, is the basic component of the Federal Register publication system. The CFR is a codification of the regulations of the various Federal Agencies.

D. Chemical Waste Landfill means an open and approved landfill, permitted under 35 IAC Subtitle G Part 814 at which protection against risk of injury to health or the environment from migration of PCBs to land, water or the atmosphere is provided from PCBs and PCB items deposited therein by locating, engineering, and operating the landfill as specified in 40 CFR 761.75.

E. Chicago Housing Authority (CHA) means the Owner of the property and the authority ordering the work specified herein.

F. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

G. Component means all removable parts/materials which make up ballasts, bulbs, batteries, and other electrical equipment, a percentage of which can be recycled.

H. Container means any portable device, in which material is sorted, transported, treated, disposed of, or otherwise handled.

I. Contractor means the entity responsible for performing the complete scope of work in the Documents. The Contractor may elect to self-perform or subcontract out any portion of the work.

J. Disposal means to intentionally or accidentally discard, throw away or otherwise complete or terminate the useful life of PCBs and PCB items. Disposal includes spills, leaks, and other uncontrolled discharges of PCBs as well as actions related to containing, transporting, destroying, degrading, decontaminating, or confining PCBs and PCB items.

K. Disposal Facility means a facility or part of a facility at which hazardous waste is intentionally placed into or on any land or water, and at which waste will remain after closure.

L. Environmental Consultant (EC) means the entity with overall responsibility for the environmental aspects of the project, including design, organization, direction, and control as well as investigations, assessments and on-site supervision of project managers.

M. EPA Identification means the unique number assigned by the EPA to each generator or transporter of hazardous waste, and each treatment, storage or disposal facility.

N. Fluorescent light ballast means a device that electrically controls fluorescent light fixtures and that includes a capacitor containing 0.1 kg or less of dielectric.

O. Facility means all contiguous land, structures, other appurtenances, and improvements on the land, used for treating, storing or disposing of hazardous waste. A facility may consist of several treatment, storage, or disposal operational units, e.g. one or more landfills, surface impoundments, or a combination of them.

P. Landfill means an open and permitted disposal facility or part of a facility where hazardous and special wastes are placed in or on land and which is not a land treatment facility, a surface impoundment, or a combination of them.

Q. Leak or Leaking means any instance in which PCB, chemical, hazardous or universal waste Article, Container or Equipment has any PCB, chemical, hazardous or universal waste residue on any portion of its external surface or surrounding area.

R. Manifest means the shipping document, EPA form 8700-22, used for identifying the quantity, composition, origin, routing, and destination of hazardous waste during its transportation from the point of generation to the point of treatment, storage or disposal.

S. On-site means within the boundaries of a contiguous property unit.

T. OSHA means the federal Occupational Health and Safety Administration.

U. Polychlorinated Biphenyls (PCBs) means any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances which contains such substance.

V. PCB Article Container means any package, can, bottle, bag, barrel, drum, tank, or other device that contains PCB Articles or PCB Equipment, and whose surface(s) has not been in direct contact with PCBs.

W. PCB Container means any package, can bottle, bag, barrel, drum, tank, or other device that contains PCBs or PCB Articles and whose surface(s) has been in direct contact with PCBs.

X. PCB Item means any PCB Article, PCB Article Container, PCB Container, or PCB Equipment, that deliberately or unintentionally contains or has as a part of it any PCB or PCBs.

Y. Recover Refrigerant means to remove refrigerant in any condition from an appliance without necessarily testing or processing it in any way.

Z. Recycle Refrigerant means to extract refrigerant from an appliance and clean refrigerant for reuse without meeting all of the requirements for reclamation. In general, recycled refrigerant is refrigerant that is cleaned using oil separation and single or multiple passes through devices such as replaceable-core filter-driers, which reduce moisture, acidity, and particulate matter.

AA. Reclaim Refrigerant means to reprocess refrigerant to at least the purity specified in Air-Conditioning and Refrigeration Institute (ARI) Standard 700-2017, "Specification for Refrigerants", and to verify this purity using the analytical methodology prescribed in the standard. In general reclamation involves the use of processes or procedures available only at the processing or manufacturing facility.

BB. Storage means the holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, destroyed, disposed of or stored elsewhere.

CC. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

DD. Toxic Characteristic Leaching Procedure (TCLP) means a laboratory test method to determine the mobility of both organic and inorganic compounds present in liquid, solid, and multiphasic wastes performed in accordance with test methods required under 40 CFR Part 261 and 268.

EE. Transporter means any person engaged in the off-site transportation of special waste and/or hazardous waste within the United States, by air, rail, highway or water, if such transportation requires a manifest under 40 CFR Part 262.

## 1.5 WORK INCLUDED

A. The work includes all labor, equipment, materials, and supplies necessary to perform the Scope of Work in the bid documents by the procedures described herein. The Contractor, by submitting a bid for the work, represents itself as knowledgeable and expert in the performance of the work, and includes all things usually and customarily necessary to provide a complete and finished job,

whether specifically mentioned or not. Related work may be shown in other related documents prepared by others, if applicable.

1.6 QUALITY ASSURANCE

A. Work outlined in this Section must be performed by a qualified Contractor, with a minimum of 10 years of experience, who is thoroughly familiar with working with regulated waste materials of similar size and scope, the Contractor must be familiar with and capable of complying with all federal, state, and local regulatory requirements pertaining to waste handling.

B. Medical Examinations: The Contractor shall provide workers with a comprehensive medical examination as required by 29 CFR 1910.134 and 29 CFR 1926.62. The examination will not be required if adequate records show that employees have been examined as required within the last year. The Contractor shall institute a medical surveillance program for all employees who are or may be exposed above the action level for more than 30 days per year.

1.7 LAWS, REGULATIONS, AND STANDARDS

A. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to hazardous, special and universal waste management and disposal/recycling.

B. Federal Requirements:

1. Federal requirements which govern the management, hauling and disposal of hazardous, special and universal waste/recycled material include but are not limited to the following:

a. DOT: U. S. Department of Transportation, including but not limited to the following:

i. Hazardous Substances, Title 49, Part 171 and 172 of the Code of Federal Regulations.
ii. Hazardous Material Regulations, General Awareness and Training Requirements for Handlers, Loaders and Drivers, Title 49, Parts 171-180 of the Code of Federal Regulations.
iii. Hazardous Material Regulations, Editorial and Technical Revisions, Title 49, Parts 171-180 of the Code of Federal Regulations.

b. EPA: U. S. Environmental Protection Agency (EPA), including but not limited to the following:

i. Management of Hazardous Wastes Resource Conservation and Recovery Act (RCRA), Title 40, Parts 260-299 of the Code of Federal Regulations.
ii. Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, and Use Prohibitions, Title 40, Parts 761, of the Code of Federal Regulations.
iii. Protection of Stratospheric Ozone, Title 40, Part 82 of the Code of Federal Regulations.
iv. Comprehensive Environmental Response, Compensation and Liability Act

(CERCLA), Title 42, Section 103.

v. Universal Waste Rule, Title 40, Part 273 of the Code of Federal Regulations.

c. LABOR: Occupational Safety and Health Administration, including but not limited to:

i. Occupational Safety and Health Guidelines, Respiratory Protection, Title 29, Part 1910.134.
ii. Occupational Safety and Health Guidelines, Occupational Safety and Health Standards, Lead, Title 29, Part 1910.1025.
iii. Occupational Safety and Health Guidelines, Occupational Safety and Health Standards, Hazard Communication, Title 29, Part 1910.1200.
iv. Safety and Health Guidelines for Construction, Title 29, Part 1926 of the Code of Federal Regulations.

C. State Requirements: Abide by all state requirements which govern the management, hauling and disposal of hazardous, special and universal waste/recycled material. In Illinois, this includes, but is not limited to the following:

1. Title 35 of the Illinois Administration Code (IAC), including but not limited to the following:

a. Waste stream Authorization, IAC Chapter I, Subpart b, Part 709.
b. Hazardous Waste Management Systems: General, IAC Chapter I, Subchapter c, Part 720.
c. Identification & Listing of Hazardous Waste, IAC Chapter I, Subchapter c, Part 721.
d. Standards Applicable to Generators of Hazardous Waste, IAC Chapter I, Subchapter c, Part 722.
e. Standards Applicable to Transporters of Hazardous Waste, IAC Chapter I, Subchapter c, Part 723.
f. Standards Applicable to Treaters, Storers, and Disposers of Hazardous Waste, IAC Chapter I, Subchapter c, Part 724.
g. Interim Status Standards of Hazardous Waste Treaters, Storers, and Disposers, IAC Chapter I, Subchapter c, Part 725.
h. Standards for the Management of Specific Hazardous Waste and Specific Types of Hazardous Waste Management Facilities, IAC Chapter I, Subpart c, Part 726.
i. Land Disposal Restrictions, IAC Chapter I, Subchapter c, Part 728.
j. Universal Waste Management, IAC Chapter I, Subchapter d, Part 733.
k. Solid Waste, IAC Chapter I, Subchapter i, Part 807.
l. Special Waste Classifications, IAC Chapter I, Subchapter i, Part 808.
m. Special Waste Hauling, IAC Chapter I, Subchapter i, Part 809.
n. Standards for New Solid Waste Landfills, IAC Chapter I, Subchapter i, Part 811.
o. Procedural Requirements for Permitted Landfills, IAC Chapter I, Subchapter i, Part 813.
p. Standards for Existing Landfills and Units, IAC Chapter I, Subchapter g, Part 814.
q. Standards for Management of Used Oil, IAC Chapter I, Subchapter e, Part 739.

D. Local Requirements: Abide by all local requirements as outlines within the Municipal Code of the City of Chicago which governs the management, hauling, and disposal of hazardous, special and

universal waste/recycled material.

1.8 SUBMITTALS

A. Before start of any hazardous waste removal Work, the Contractor must submit a Hazardous Waste Management Plan to the EC fifteen (15) days prior to the start of Work.

B. During the Work, the Contractor must submit the following to the EC, with ten (10) days of activity, off-site removal, or completion of work if duration is less:

1. TCLP test results, as required to characterize waste paint chip debris for segregation and packaging purposes prior to transport from the site.
2. Submit copies of all executed manifests and disposal site receipts and waste quantities within ten (10) days to the EC.
3. Receipts for all recycled materials accepted at authorized recycling facilities. The receipts will include the number of components recycled as well as the amount of materials recycled and/or disposed.
4. Documents for the removal, handling, recycling or disposal of CFC Refrigerant/Reclamation.
5. Daily Reports – list names of active workers for each day, work starting and stopping times, visitors to the site, and description of Work accomplished.

C. Submittal Review:

1. Review of submittals or any comments made do not relieve the Contractor from compliance with the requirements of the contract specifications and drawings. The purpose of this check is to review for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents.
2. The Contractor must not begin any Work applicable to this section until all required submittals have been reviewed and accepted by the EC.

1.9 HAZARDOUS WASTE PLAN REQUIREMENTS

A. General Applicability of Codes and Regulations:

1. Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable codes and regulations have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.

B. Contractor Responsibility:

1. Notice shall be provided to CHA's Designated Representative a minimum of 2 working days prior to the removal of any hazardous, special or universal waste and/or recycled hazardous, special or universal waste from the site.
2. Notice will be provided to CHA's Designated Representative within 4 hours of any environmental problems, complaints, fines, citations or issues by any government body or regulatory agency pertaining to hazardous, special or universal waste management and disposal. Written confirmation will be provided to CHA's Designated Representative

within 48 hours of the incident that indicates that all problems and issues have been satisfactory addressed.

C. The Contractor must prepare a Hazardous Waste Plan designating appropriate procedures and equipment for performing the Work. The Hazardous Waste Plan must address the proper management/handling and disposal/recycling of wastes generated during Work activities. The Contractor's Hazardous Waste Plan for this project must include as a minimum the items listed below:

1. List of Hazardous Waste Equipment:

   a. A description of the proposed equipment to be used during the removal, handling, temporary storage and transport of hazardous materials related to the Work.

2. Hazardous Material Handling:

   a. Procedures including a description of the method of transportation and storage of each type of hazardous material, for movement on and off site.
   b. Contractor shall provide a description of procedures for on-site characterization of chemicals for consolidation prior to disposal/recycling.
   c. The plan will include the following documentation for each transporter:

      i. A copy of state and local special waste and/or hazardous waste hauler licenses for each transporter must be provided in the Plan.
      ii. U.S. EPA Identification Number of waste hauler.
      iii. Current list of all transporting vehicles to be used including:
         a. Vehicles make, model and year.
         b. Serial number for each vehicle.
         c. Vehicle license number.
         d. Number of axels.
         e. Weight capacity of vehicle.

   d. A list of all licensed qualified truck drivers. Drivers should be able to provide their drivers license upon request.
   e. Instances where rail haulers are being used, copies of all applicable permits and licenses for the load on/off site location(s) and/or transfer location(s) will be provided.

3. Contractor shall provide the following documentation for each disposal/recycling facility:

   a. Name and address of waste disposal facility where hazardous waste materials are to be disposed including:

      ii) Contact person and telephone number.
      iii) Copy of state license and permit.
      iv) Disposal facility permits.

   b. A signed statement from an authorized representative of the recycling or disposal facility stating the percentage of recycled materials for each of the components including the estimated percentage pertaining to each component which has no recycling value.

4. Safety Precautions –Personnel:

   a. List safety equipment and clothing to be used per OSHA regulations.
   b. A description of emergency procedures to be followed in case of physical contact, ingestion, inhalation, etc.

5. Emergency Spills:

   a. A description of methods to be used for containment.
   b. A description of methods to be used for collection and disposal.
   c. A description of methods and materials to be used to restore areas harmedby emergency spills.

6. Lead-containing Paint Management:

   a. A description of the work procedures that will be utilized to minimizethe generation of airborne lead into the environment.

7. In addition, the Plan will provide:

   a. Specimen copy of Uniform Hazardous Waste Manifest form.
   b. Copy of EPA "Notice of Hazardous Waste Activity" form.
   c. Copy of forms and permits required by federal, state, and local agencies.
   d. Sample of disposal label(s) to be used.

**PART 2 - PRODUCTS**

2.1 EQUIPMENT/MATERIALS

A. Disposal Bags: Provide 6 mil (0.15 mm) thick leak-tight polyethylene bags.

B. DOT Hazardous Waste Disposal Drums: Provide DOT 17-H Open -Top Drums (55-gallon) in accordance with DOT title 49 CFR Parts 173, 177, 178, and 179.

C. Fiberboard Drums, cylindrical containers manufactured from sturdy fiberboard will be utilized for storage transportation of electrical equipment.

D. PCB containing ballasts shall be place in 55-gallon drums with vermiculite packing. The drums will be sealed, and labeled as containing hazardous PCB waste. The label shall also include the name and address of the parcel. However, if ballasts are damaged they shall be stored prior to disposal in accordance with 40 CFR 761.65.

E. DOT Hazardous Waste Labels: in accordance with DOT regulations Title 49 CFR parts 173, 177, 178, and 179.

F. Corrugated "Gaylord" Boxes with the use of a liner will be used to store and transport bulk materials which will be kept on pallets during storage and transportation.

G. Materials to be used to restore areas harmed by emergency spills.

H. Safety equipment and associated clothing to be used.

I. Hazardous material manifests and other related forms required by state and local agencies.

J. Utilize equipment to recover refrigerant that is appropriate for the following:

1. Type of system encountered
2. Refrigerant type
3. Achieving IEPA-mandated vacuum levels

**PART 3 - EXECUTION**

3.1 GENERAL REQUIREMENTS

A. The Contractor shall train each employee performing Work prior to the time of initial job assignment in accordance with applicable regulations.

B. Respiratory Protection Program:

1. The Contractor shall furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every 6 months thereafter if required by 29 CFR 1910.1025.
2. The Contractor shall establish and implement a respiratory protection program as required by 29 CFR 1910.134 and 29 CFR 1926.62.

C. Hazard Communication Program: Establish and implement a Hazard Communication Program as required by 29 CFR 1910.1200.

D. Post warning signs at entry points to hazardous Work area, as necessary.

E. Segregate, package, label, transport and dispose of Hazardous Waste in accordance with DOT, EPA, state, and local regulations.

F. Scheduling/Sequencing of the demolition and/or abatement is to be coordinated by the Contractor.

G. Contractor shall decontaminate all residues from all surfaces where pre-existing leaks occur. Contractor shall decontaminate all surfaces where leaks occur during the removal and disposal process.

H. Extreme care shall be used to prevent leakage of chemicals, liquid wastes, refrigerant, etc. during removal processes.

I. Do not mix potentially hazardous waste streams or different refrigerants in the same recovery vessel. Where feasible, separate each type of hazardous waste from other types of hazardous wastes and construction waste.

J. All electrical circuits shall be de-energized and locked out prior to removal of ballasts. Contractor shall provide temporary lighting as needed.

K. The Contractor shall identify the location and Commissionership of all on-site transformers. The

contents from each transformer shall be characterized for PCB content by the Contractor for proper disposal.

L. The Contractor shall determine location and type of each radiological waste. The Contractor shall make all arrangements from the proper decommissioning of equipment and disposal of related materials.

3.2 HAZARDOUS WASTE DESIGNATION

A. Where not otherwise designated by the CHA as hazardous waste, characterize applicable suspect waste products by conducting representative TCLP testing and referencing 40 CFR Part 261.

B. Work shall include characterization and proper disposal of any soot contained within boilers, incinerators, or stacks; maintenance fluids within heating/cooling equipment; hazardous chemicals; storage tanks; or lead content of paint present.

C. Fluids from transformers, electrical equipment, hydraulic equipment, etc. shall be characterized for PCB content per 40 CFR Part 761.

D. Representative sampling of waste products will be in accordance with EPA Document SW 846.

E. TCLP test analysis will be performed in accordance with EPA Method 1311.

F. Radiological Wastes shall be classified in accordance with the NRC operating agreement.

3.3 HAZARDOUS WASTE

A. The following waste products are designated by CHA as non-salvageable and as Hazardous Waste Types:

1. Waste Type A: PCB waste.

    a. PCB-containing ballasts from fluorescent light fixtures.
    b. PCB-containing electrical transformers and switch gears.
    c. PCB-containing hydraulic fluid, which can be found within but not limited to the following equipment:

        i. Hydraulic-lift elevators
        ii. Hydraulic trash compactors
        iii. Hydraulic loading dock lifts

2. Waste Type B: Mercury-containing waste.

    a. Thermostats with mercury switches. Individually bagged mercury-containing thermostats.
    b. Fluorescent and mercury-vapor lamps/bulbs.
    c. Thermometers.
    d. Gauges and regulators (including those found in waste medical equipment).
    e. Elemental mercury.

3. Waste Type C: Medical Waste.

    a. Used and unused sharps.
    b. Contents of bio-hazard waste containers, including drums and bins.
    c. Surplus medical supplies.
    d. Contents of medical devices, such as dialysis machines, ventilators.
    e. Human and animal pathological wastes including tissue samples stored on slides and preserved and unpreserved specimens.

4. Waste Type D: Chemical Wastes.

    a. Cleaning chemicals such as bleach, ammonia, carpet cleaner, etc.
    b. Laboratory chemicals such as xylenes, benzene, acetic acid, dyes, formaldehyde, etc.
    c. Boiler and water treatment chemicals.
    d. Developing chemicals associated with the processing of x-rays and other photographic images, both used and virgin product.
    e. Unused medicine.
    f. Building maintenance chemicals such as paint, adhesives, glazing compound, caulk compound, roofing materials, concrete binder, resurfacing compounds, etc.
    g. Equipment maintenance chemicals such as lubricants, solvents, and oils.
    h. Fuels, such as gasoline, No. 2 Fuel Oil, and diesel fuel.
    i. Equipment and vessels containing chemicals, such as fire extinguishers, gas cylinders, batteries, and film developing equipment.

5. Waste Type E: Refrigerants and CFCs

    a. Refrigerators and freezers.
    b. Air Conditioning units.
    c. Cryogenic Supplies.
    d. Bulk storage of refrigerants.

6. Waste Type F: Equipment

    a. Mechanical equipment, such as compressors, generators, compressors, water conditioning vessels, motors, etc.
    b. Electrical equipment such as televisions, computers, monitors, current controllers, etc.
    c. Medical equipment such as vital signs monitors, incubators, crash carts, MRIs, ultrasounds, ventilators, dialysis machines, etc.

7. Waste Type G: Radiological Waste

    a. Drummed Radioactive waste.
    b. Equipment that uses a radioactive source including x-rays, mammograms, CAT scans, electron microscopes, scintillation spectrometers, etc.
    c. Smoke detectors.

8. Waste Type H: Lead-containing waste.

    a. Lead paint (liquid or containerized paint wastes).

b. Lead-contaminated wastes (paint chips, loose debris, etc.).

9. Waste Type I: Other

a. Drums of hazardous waste generated prior to the start of the contract.
b. Wastes accumulated in Crock Pots.
c. Lab trap drain wastes.
d. Soot encountered in stacks, incinerators, or associated equipment.

## 3.4 HAZARDOUS WASTE PACKAGING AND LABELING

**A.** Package each segregated Hazardous Waste Type in containers for offsite removal and disposal/recycle. **IMPORTANT: Do Not Mix Waste Streams.**

1. Waste Types A, B, C and I, as applicable:

a. Package in DOT 17-H Open-Top Drums polyethylene disposal bag liners in accordance with 49 CFR Parts 171-180.
b. Fill to capacity only with waste.
c. Install gasket on lid, apply lock ring, and seal.
d. Apply Hazardous Waste Label to drum side.
e. Enter required DOT shipping data per applicable regulations.
f. Adjacent to each label, enter the date indicating when waste was first placedin each drum.

2. Waste Type D – Chemical Wastes:

a. Package other wastes as applicable in accordance with Hazardous Wastes Resource Conservation and Recovery Act (RCRA), Title 40, Parts 260-299 of the Code of Federal Regulations. Overpack drums shall be required as necessary to complete Work.

3. Waste Type E – Refrigerants and CFCs:

a. Reference Section 3.8 for details.

4. Waste Type F – Equipment:

a. Package all equipment in closable and lockable containers for off-site removal. Ensure that all liquids, gases or other regulated materials are removed from equipment, as applicable, prior to placement in containers. Comply with all DOT regulations for each type of equipment.

5. Waste Type G – Radiological Wastes:

a. All radiological equipment shall be packaged and shipped in accordance with 32 IAC 341 regulations.

6. Waste Type H – Lead-containing Wastes:

a. Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265.
b. Comply with land disposal restriction notification requirements as required by 40 CFR 268.
c. Non-hazardous waste may be disposed of as demolition debris (general refuse).
d. Submit results of TCLP testing to the EC prior to disposal.

B. Sealed and Labeled Containers: maintain all containers in a continuously sealed condition after they have been sealed.

1. Do not reopen sealed containers
2. Do not place additional waste in sealed containers.

3.5 TEMPORARY STORAGE

A. Partially filled containers of hazardous waste may be stored at the Work site for intermittent packaging provided that the following conditions are met:

1. Each container is properly labeled when it is first placed in service, including the date;
2. Each container remains closed at all times except when compatible waste types are added;
3. Each Work site must be secured and/or attended at all times; and
4. When moved from site to site, each container remains within the geographic boundaries of the facility without moving nor crossing public access highways; and
5. **UNDER NO CIRUMSTANCES WILL THE ACCUMULATED WASTE REMAIN ON SITE BEYOND NINETY (90) DAYS FROM THE DAY THAT ACCUMULATION IN THE CONTAINER WAS INITIATED.**

3.6 REMOVAL OF HAZARDOUS WASTES

A. Immediately seal containers of hazardous waste as each the container is filled. Remove containers of hazardous waste from the Work site within forty-eight (48) hours of being filled.

B. Transporting filled containers from the Work site to an approved disposal site or recycling center utilizing licensed hauler.

C. All fluorescent light ballasts shall be removed. Those labeled “NO PCBs” shall be packaged separately from those which indicate PCB or do not indicate PCB condition.

D. Subject to CHA’s Designated Representative’s approval, the Contractor shall arrange with the electric utility provider for the removal of transformers which are owned by the utility provider from the site.

E. Subject to CHA’s Designated Representative’s approval, the contractor shall remove and dispose of all transformers which are not owned by the electric utility provider.

F. Continuously maintain custody of all hazardous material generated at the Work site including security, short-term storage, transportation and disposition until custody is transferred to an

approved disposal site or recycling center.

G. Do not remove, or cause to be removed, hazardous waste from the Property without a legally executed Uniform Hazardous Waste manifest.

H. At completion of hauling and disposal of each load, submit copy of waste manifest, chain of custody form, and landfill receipt to CHA's Designated Representative.

## 3.7 RECYCLING AND RECOVERY

A. Turn over waste which contains materials for which recovery and/or recycling is possible to an approved recycling center. Materials subject to recycling include, but are not limited to:

1. Fluorescent light tubes.
2. Lead acid batteries.
3. Combustible lead-based painted building components and lead-based paint chips.
4. Televisions and computers.
5. Ethylene Glycol or other related fluids found within cooling systems.
6. Mechanical and medical equipment.
7. Non-PCB-containing oils.
8. Fuel.
9. Maintenance chemicals.
10. Gas cylinders and fire extinguishers.
11. Lead Shielding Materials.

## 3.8 STORAGE & TRANSPORTATION OF REFRIGERANTS / CFCs

A. Use proper storage vessel when recovering refrigerants.

1. IDOT containers meeting the ARI standard.
2. Container working pressure rating must comply with IDOT requirements (49 CFR).

    a. For Refrigerant HCFC-22: Minimum working pressure rating of 260 psig.
    b. For Refrigerant CFC-11 (Low-Pressure Refrigerants): Drums of steel construction and designated as 17C or 17E.

3. Open top and plastic drums shall not be used.
4. Previously filled, disposable cylinders shall not be used to store or transport recovered refrigerants.

B. All recovery vessels shall be visually inspected by the Contractor prior to filling. The Contractor shall inspect and provide the following upon request:

1. Verification of proper IDOT specification.
2. Pressure rating verification.
3. Current hydrostatic test date.
4. Cylinder shall be free of surface dents and imperfections.

C. Provide required labeling for recovery vessel.

D. Return all refrigerant to reclamation facilities to be reprocessed to ARI 700 1988 Standards or dispose in an approved facility.

E. The Contractor shall provide CHA's Designated Representative with required documents for CFC Refrigerant/Reclamation within ten (10) days.

3.9 REMOVAL OF NON-HAZARDOUS WASTE MATERIAL

A. Transport and legally dispose of non-hazardous waste products, materials, residues and refuse at a location not on City's property.

B. Non-hazardous waste products, materials, residues and refuse include, but are not necessarily limited to:

1. Materials which are determined to be non-hazardous wastes through objective sampling in accordance with EPA Document SW-846 and laboratory analysis in accordance with EPA Method 1311.
2. Emptied hazardous material containers: containers holding a material with constituents listed on the SDS as hazardous.

    a. When a container is emptied of its hazardous contents by pouring or scraping so that less than one inch of material remains in the bottom of the container, the container is considered "empty" and is not in itself a hazardous waste.
    b. Emptied hazardous material containers may be disposed of as construction debris waste (i.e. non-hazardous).

3. Personal protective clothing and safety equipment with de minimis or trace contamination.

C. Keep premises in a clean and orderly condition during performance of all Work.

D. Place non-hazardous construction debris wastes in secure containers for local landfill disposal on a daily basis.

**END OF SECTION**

**SECTION 02 87 13**

**ANIMAL EXCREMENT AND CARCASS ABATEMENT**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings

1.2 APPLICABILITY

A. These specifications apply for all Chicago Housing Authority (CHA) demolition, construction, and renovation projects that require the removal and disposal of animal excrement and carcasses in accordance with all applicable regulations.

1.3 INTRODUCTION

A. Animal excrement, primarily bird and bat droppings, accumulates on and around the outside of CPS buildings, and also some interior building areas. Animal droppings create an environment favorable to the development of microbiological organisms potentially harmful to humans and impede building renovation activities. These specifications specify procedures for the safe and effective abatement of animal excrement.

1.4 DEFINITION

A. In addition to the terms listed below, all definitions in the laws and regulations specified elsewhere in the specifications are incorporated by reference, whether or not restated herein.

B. Architect means any person or firm employed by CHA for the purpose of designing the project.

C. Abatement Contractor means the entity responsible for performing the complete scope of work in the Documents.

D. Abatement Supervisor, hereinafter referred to as "Supervisor" means any person who supervises abatement workers. This person must be trained, accredited, and licensed as required.

E. Chicago Housing Authority (CHA) means the owner of the property and the authority ordering the work specified herein.

F. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

G. Environmental Consultant (EC) means the entity with overall responsibility for the environmental aspects of the project, including design, organization, direction, oversight and control as well as investigations, assessments, and supervision of project manager.

H. Contractor or in case of stand-alone projects Abatement Contractor means the entity responsible for performing the complete scope of work in the bid documents. The Contractor may elect to self-perform or subcontract out any portion of the Work.

I. HEPA Filter means a High Efficiency Particulate Air filter capable of trapping 99.97% percent of particles greater than 0.3 micrometers in mass median aerodynamic equivalent diameter.

J. IDPH means the Illinois Department of Public Health.

K. Environmental Consultant (EC) designs the environmental work, maintains the documents, conducts oversite, and reviews the environmental work, submittals, and reports.

L. OSHA means the federal Occupational Health and Safety Administration.

M. Plasticize means to apply plastic sheeting over surfaces or objects to protect them from contamination or water damage.

N. Personal Protective Equipment (PPE) means the protective suits, head and foot covers, gloves, respirators and other items used to protect persons from potential hazards.

O. RCRA means the Resource Conservation and Recovery Act and associated regulations as referenced in Laws, Regulations and Standards specified elsewhere in the specifications.

P. SDS means Safety Data Sheets, required by OSHA for any chemical in the workplace that that could be expected to cause an exposure to workers during normal use or in emergency situations.

Q. Work means the obligations of the Contractor under the Contract Documents. Work includes, unless specifically excepted by the Contract Documents, the furnishing of all materials, labor, equipment, supplies, plant, tools, scaffolding, transportation, superintendence, permits, inspections, occupancy approvals, insurance, taxes, and all other services, facilities and expenses necessary for the full performance and completion of the requirements of the Contract Documents. Work also means that which is furnished, produced, constructed, or built pursuant to the Contract Documents.

R. Work Area means the area or areas where abatement is being conducted.

## 1.5 WORK INCLUDED

A. The Work includes all labor, equipment, materials, and supplies necessary to perform the Scope of Work in the bid documents by the procedures described herein. The Contractor, by submitting a bid for the Work, represents itself as knowledgeable and expert in the performance of the Work, and includes all things usually and customarily necessary to provide a complete and finished job, whether specifically mentioned or not.

B. Removal of animal excrement, carcasses, and contaminated debris shall be conducted at all locations throughout the interior and exterior of the building where specifically mentioned in the environmental scope of work. All excrement removal/cleanup work shall be conducted as necessary and as often as needed, to complete general construction activities and promote the health and welfare of the building occupants.

C. Removal of animal excrement and/or associated contaminated soil listed in the bid documents, including isolating the Work Areas, protection of adjacent areas, cleanup, proper packaging and disposal of wastes, and all other steps necessary to complete the scope of work.

D. Repair or replacement of damaged surfaces, fixtures, or furnishings to restore them to their pre-existing condition to the satisfaction of CHA's Designated Representative and EC.

E. When the bid documents include lead and asbestos abatement items in the same spaces, typically animal excrement abatement shall be performed first.

F. Waste droppings and soil when not otherwise contaminated, may be disposed of as normal construction waste.

G. Compliance with all applicable laws, regulations, standards, and these specifications. In the case of a conflict, the contractor shall comply with the most stringent.

H. All licenses, accreditations, permits, fees, notifications, reports, or other documents required by law, regulation, this specification, or the bid documents.

## 1.6 LAWS, REGULATIONS AND STANDARDS

A. The following laws, regulations, and standards are incorporated by reference:

1. 29 CFR 1910: OSHA General Industry Standards.
2. 29 CFR 1926: OSHA Construction Standards.

## 1.7 MONITORING

A. The EC will provide project monitoring independent from the contractor, as follows:

1. Prior to the start of the Work:

   a. Confirm the locations and amounts of previously identified suspect materials, and assume they are contaminated with microbiological growth.

2. During the Work:

   a. Observe the Work periodically for compliance with project specifications.
   b. The EC may stop the Work if abatement materials are not being maintained wet, or airborne emissions are observed. The Contractor shall be responsible for taking corrective action to prevent recurrence, and cleaning adjacent areas that become contaminated by the abatement activities.

3. Upon completion of the Work:

   a. Visually inspect for visible debris. The Contractor shall be required to re-clean the area or portions of areas until no visible debris remains.
   b. The EC will confirm and document that proper cleanup and disinfection procedures were followed.

1.8 SUBMITTALS BY THE CONTRACTOR

A. Evidence that all contractor employees in the Work Areas are trained and accredited in accordance with OSHA and specification requirements:

1. Proof of animal excrement abatement training, as specified elsewhere in the specifications.
2. Physician's written opinion to perform asbestos abatement and wear a respirator.
3. Respirator fit test for negative pressure respirators.

B. Waste Disposal Receipt.

**PART 2 - PRODUCTS**

2.1 TOOLS AND EQUIPMENT

A. All equipment shall at least conform to minimum industry standards.

B. Equipment:

1. Respirators shall be NIOSH-approved for use with contaminants anticipated in the Work.
2. Full-body safety harnesses shall be used with approved lanyards for fall protection. Safety belts are not permitted.
3. Other safety equipment, such as hard hats, eye protection, gloves, and footwear shall comply with their respective ANSI standards.
4. Negative air machines shall provide HEPA filtration and conform to ANSI Z9.2 fabrication criteria.

C. Tools:

1. Shovels and scoops. Plastic or rubber models are recommended.
2. Scrapers, brushes, utility knives, and other hand tools which shall not cause damage to building surfaces.
3. Power tools such as, but not limited to saws, pneumatic chisels, brushes, sanders, and needle guns shall be equipped with shrouds and HEPA-filtered local exhaust systems to capture released particles.

2.2 MATERIALS

A. Installed materials which become a part of the Work shall be of good quality, non- lead-bearing, free of asbestos, and conform to the respective reinstallation specification sections.

B. Abatement Materials:

1. Poly sheeting for all applications shall be 6-mil nominal thickness.
2. Tape shall be 2 or 3 inch duct tape or other waterproof tape suitable for joining poly seams and attaching poly sheeting to surfaces.
3. Spray adhesives shall be non-flammable and free of methylene chloride solvents.
4. Disposal bags shall be 6-mil.

5. Disposable suits, hoods, and foot coverings shall be TYVEK or similar.
6. Solvents shall be compatible with any primers, mastics, adhesives, paints, coatings, or other surfacing materials to be installed following their use.
7. Cleaners shall be alkaline, non-phosphate based solutions.
8. Disinfectants shall be EPA approved solutions manufactured for the eradication of bacteria.

**PART 3 - EXECUTION**

3.1 EMPLOYEE TRAINING, QUALIFICATION, AND MEDICAL SCREENING

A. Supervisors and Workers shall have successfully completed training in animal excrement abatement. This training shall be conducted by a Certified Industrial Hygienist or other professional knowledgeable in the potential hazards and safe removal of animal excrement, and include, at a minimum, the following:

1. Potential risks, diseases, and health effects.
2. Engineering and administrative controls.
3. Work practices, including wet removal, cleaning, and disinfecting methods.
4. PPE usage, including respirator training and fit testing.
5. Waste packaging, handling, and disposal.
6. Specification requirements.

B. Medical Screening. All Contractor personnel shall have a current medical examination. An occupational physician shall assist the contractor in selecting personnel for cleanup of animal excrement. Medical screening shall include general health status, conditions that may increase risk of infection by fungi, resistance to histoplasmosis, and a respiratory examination, including pulmonary function tests, to determine the capability to wear a respirator. Copies of the physician's written opinions shall be kept on site.

3.2 RESPIRATORY PROTECTION

A. Respiratory protection shall be worn as shown on the following chart:

| TASK | RESPIRATOR TYPE |
|---|---|
| Exterior Work | Full-face APR w/ HEPA filters |
| Interior Work | Full-face PAPR w/ HEPA filters |

B. Contractor shall have a written respiratory protection program in accordance with Laws, Regulations and Standards, specified elsewhere in the specifications, for airborne biological hazards.

3.3 HYGIENE PRACTICES

A. Eating, drinking, smoking, chewing gum or tobacco, and applying of cosmetics are not allowed in the Work Area.

B. Personal Protective Equipment (PPE) shall be worn throughout excrement cleanup and disinfection procedures to protect against potential pathogenic biological hazards, and skin and respiratory irritation from use of cleaners and disinfectants. All persons entering the Work Area shall wear appropriate PPE, and shall follow the entry and exit procedures posted in the Personnel Decontamination Enclosure System.

C. Personal protection equipment shall include:

1. Respirators
2. Full body disposable suits, headgear, and footwear.
3. Gloves.
4. Hard hats.
5. Non-disposable footwear and clothing shall remain in the Work Area shall be disposed of as contaminated material or decontaminated when the job is completed.
6. Authorized visitors shall be provided with suitable PPE when PPE is required in the Work Area.

D. For Interior work, a Personnel Decontamination Facility is required. Provide at least four air-changes per hour within the decontamination unit. The decontamination unit may be remotely located if not feasible to locate adjacent to the Work Area.

1. When a remote decontamination (decon) unit is used, personnel shall use a double-suiting procedure for traveling between the Work Area and the decon. Persons shall HEPA-vacuum the exterior of their disposable suits at the entry to the Work Area, put on a clean suit over the existing suit, and proceed to the decon unit for decontamination, and change into street clothes.
2. For Exterior work, a remote decon facility shall be used.

## 3.4 PROHIBITED ACTIVITIES

A. Use of high-pressure water to wet accumulated excrement.

B. Dry removal or dry sweeping.

C. Use of compressed air for cleaning.

D. Use of high speed power tools not equipped with a HEPA-filtered local exhaust system.

E. Use of tools that can damage building surfaces, such as coarse wire brushes.

## 3.5 WORK AREA ISOLATION AND PREPARATION

A. General Preparation:

1. Post warning signs at entrances to the Work Area. Wording shall be at least two inches high stating, “Warning. Potential Inhalation Hazard. Unauthorized Entry Prohibited”.
2. Secure the Work Area from entry by unauthorized persons.

B. Exterior Preparation:

1. 6-mil plastic sheeting shall be placed over the ground, foundation, or other surfaces below the abatement area.
2. Unauthorized entry shall be prevented by using appropriate barriers, such as warning tape, fencing, or other suitable barriers.
3. Nearby air intakes, grilles, windows, and other openings into the building interior shall be sealed off with poly and tape. Building air handling systems shall be turned off.
4. All electric power in the Work Area shall be protected with ground-fault circuit interrupters.

C. Interior Preparation:

1. Immoveable objects shall be pre-cleaned and protected with 6 mil poly sheeting and sealed with tape. Moveable objects shall be pre cleaned and moved from the Work Area and stored in a location designated by the EC.
2. Unauthorized entry shall be prevented by using appropriate barriers, such as warning tape, fencing, or other suitable barriers.
3. Air intakes, grilles, windows, doors, and other openings shall be sealed off with poly and tape. Forced air ventilation systems shall be turned off.
4. Turn off electrical circuits in the Work Area as much as possible. All electric power in the Work Area shall be protected with ground-fault circuit interrupters.
5. Negative air machines (NAMs) shall be installed in the Work Area and exhausted to the outside to create a negative pressure in the Work Area. A sufficient number of NAMs shall be installed to provide four air changes per hour. NAMs shall remain in continuous operation until final clearance is obtained.

## 3.6 ABATEMENT PROCEDURES

A. Accumulated materials shall be saturated with a disinfectant solution using a low-velocity mist spray, and kept wet during removal.

B. Clean up small amounts of fresh droppings by saturating with a disinfectant solution, and scraping or hosing with water.

C. Remove bulk material in such a way as to prevent debris from becoming airborne.

D. Materials shall be double-bagged or containerized as it is removed. Remove waste containers from Work Area by hand or chute. Wastes shall not be dropped or thrown.

E. Appropriate OSHA protection shall be provided, as needed. The Contractor is responsible for compliance with all applicable OSHA regulations and guidelines.

## 3.7 CLEANING AND DECONTAMINATION

A. All visible accumulations of droppings, debris, waste containers, tools, and unnecessary equipment shall be removed from the Work Area. Reusable tools and equipment shall be cleaned and disinfected using materials specified prior to removal from Work Area.

B. Protective poly shall be folded in on itself, rolled up, and placed in 6-mil disposal bags.

C. Work Area surfaces shall be HEPA vacuumed.

D. Clean and disinfect Work Area surfaces using materials specified.

3.8 FINAL CLEARANCE

A. Cleaning may be discontinued when no visible debris is present, and upon completion and verification of proper cleaning and disinfecting of exterior and interior surfaces. The cleaning and disinfection process will be considered complete once the contractor has received written verification from the EC on site representative that no visible debris is present.

3.9 WASTE DISPOSAL AND EQUIPMENT LOAD-OUT

A. Packaging Waste:

1. All wastes, including removed droppings and soil, containment poly, critical barrier materials, suits, respirator filters, vacuum HEPA filters, water filters, and other potentially contaminated items shall be properly packaged for disposal.
2. Use 6-mil plastic bags with “goose-neck” seal, or other impermeable containers.
3. Wrap large or irregular items in 6-mil poly sheeting and seal with tape.
4. Sharp, jagged, or other items that may puncture poly shall be packaged in rigid impermeable containers such as drums or boxes, or wrapped in burlap or other protective covering before sealing in bags or poly sheeting.
5. Label containers with name and address of generator and abatement location.

B. Removing Items from Work Area:

1. Packaged wastes shall be HEPA-vacuumed before removing from the Work Area.

C. Storage of packaged wastes shall be in an enclosed dumpster or other suitable container that can be secured. The secured container shall be kept locked at all times to prevent unauthorized access.

D. Shipment of Items from Project:

1. Decontaminated wastes and debris may be disposed as normal construction and demolition debris.
2. Decontaminated tools and equipment may be shipped by normal carrier to warehouse, another job site, or other destination.

E. Packaged wastes shall be disposed of only in landfills approved and permitted for accepting construction debris.

**END OF SECTION**

**SECTION 03 01 30**

**MAINTENANCE OF CAST-IN-PLACE CONCRETE**

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes concrete repair including repair of spalled or missing concrete and voids using concrete repair mortar; repair of cracks in concrete.

B. Spalls, Missing Concrete: Concrete repair work of spalled or missing concrete includes:
1. Exposing and undercutting reinforcing steel.
2. Repairing, cleaning, and treating reinforcing steel.
3. Edge and surface conditioning of concrete area to be patched.
4. Application of bonding agent.
5. Application of concrete repair mortar.
6. Finishing of concrete patch to match adjoining surfaces.

C. Cracks: Concrete crack repair work includes:
1. Cleaning surface of cracked concrete.
2. Application of gravity penetrating crack sealer to repair hairline surface cracks.
3. Epoxy pressure injection of cracks to repair cracks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: Cured Samples for each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product Data: Submit product data for proprietary materials and items, including patching materials and forming accessories, bonding compounds, curing and coating compounds.

B. Repair Procedures: Submit repair mortar manufacturer’s narrative description of procedures and methods for removal of concrete, repairing and cleaning of reinforcing steel, and applying new repair mortar and coatings.

C. Statement of Application: Provide statement, signed by authorized representative of patching materials manufacturer, that manufacturer has reviewed contract documents and project conditions relating to concrete repair and that manufacturer's materials proposed for use are suitable for the applications indicated.

D. Certification: Submit manufacturer's certification that products provided comply with specified requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall have not less than 5 years successful experience providing concrete repairs similar in size and complexity to that required for this project, and shall be approved by the repair material manufacturer.

B. Standards: Comply with provisions of the following Codes and Standards, except where more stringent requirements are shown or specified:
   1. ACI 318, "Building Code Requirements for Reinforced Concrete: latest edition.
   2. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice", latest edition.

C. Testing: The Owner may engage a testing laboratory to perform material evaluation tests.
   1. Materials and installed work may require testing and re-testing at any time during progress of the work. Re-testing of rejected materials for installed work, shall be done at the Contractor's expense.

D. Preparation Field Sample: Provide a field sample of concrete prepared for application of repair mortar, including undercutting and preparation of reinforcing steel, for Architect's review prior to proceeding with coating. Sample shall be an area approximately 1'-0" x 1'-0". Locate as determined by the Architect.

E. Concrete Mortar Repair Field Sample: Provide an in-place field sample installation of one mortar patch area of spalled concrete for Architect's review prior to proceeding with repairs. Install field sample at final approved preparation sample specified above, in the presence of the Architect.

1.5 PROJECT CONDITIONS

A. Environmental Conditions: Perform concrete repairs only when weather and forecasted weather conditions comply with requirements of repair material manufacturer.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Concrete: Plywood panel materials, to provide continuous, straight, smooth, exposed surfaces.
   1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form", Class I.
   2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

2.2 REINFORCING MATERIALS

A. Replacement Reinforcing Bars: ASTM A 615, Grade 60 deformed.

B. Supports for Reinforcement: Provide supports for replacement reinforcement as necessary including wire ties and spacers, and other devices for spacing, supporting, and fastening reinforcing bars in place.

## 2.3 MANUFACTURERS

A. Source Limitations: For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

## 2.4 BONDING AGENTS

A. Bonding Agent: Multi-component, solvent-free, moisture-tolerant epoxy-modified cementitious product formulated as a bonding agent and anti-corrosion coating.
   1. Corrosion Inhibition: Material shall have been proven by independent laboratory testing to prevent corrosion of reinforcing steel when tested under procedures of the Federal Highway Administration Program Report FHWA/RD88/193.
   2. Bond Strength:
      a. Plastic Concrete to Hardened Concrete: Wet on Wet: 2800 psi min., 14 days moist cure, per ASTM C 882.
      b. Steel Reinforcement to Concrete: 625 psi min., pullout test.
   3. Product:
      a. Provide Sika Armatec 110 EpoCem; Sika Corp.
      b. Provide Sto Epoxy Adhesive; Sto Concrete Restoration Division.

## 2.5 PATCHING MORTAR

A. Patching Mortar Requirements:

   1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
   2. Color and Aggregate Texture: Provide patching mortar and aggregates of colors and sizes necessary to produce patching mortar where indicated that matches existing, adjacent, exposed concrete. Blend several aggregates if necessary to achieve suitable matches.
   3. Coarse Aggregate for Patching Mortar: ASTM C33/C33M, washed aggregate, Size No. 8, Class 5S. Add to patching-mortar mix only as permitted by patching-mortar manufacturer.

B. Repair Mortar: Silica fume polymer-modified portland cement mortar intended for use as a patching mortar at thicknesses of 1/2" and greater, freeze-thaw resistant, compatible with coefficient of thermal expansion of concrete.
   1. Flowable Mortar:
      a. Bond Strength: 2200 psi at 28 days, per ASTM C 882 modified.
      b. Flexural Strength: 720 psi min at 28 days, per ASTM C 293.
      c. Splitting Tensile Strength: 500 psi min. at 28 days, per ASTM C 496.
      d. Compressive Strength: 3000 psi at 1 day, 6500 psi at 28 days, per ASTM C 109.
      e. Product:
         1) Provide SikaTop 111 Plus; Sika Corp.

2) Provide Sto Flowable Mortar; Sto Concrete Restoration Division.

2. Non-Sag Mortar:
   a. Bond Strength: 1000 psi at 28 days, per ASTM C-882 modified.
   b. Flexural Strength:1000 psi min at 28 days, per ASTM C-293.
   c. Splitting Tensile Strength: 400 psi min. at 28 days, per ASTM C-496.
   d. Compressive Strength: 1500 psi at 1 day, 4300 psi at 28 days, per ASTM C-109.
   e. Product:
      1) Provide SikaTop 123 Plus; Sika Corp.
      2) Provide Sto Trowel Grade Mortar; Sto Concrete Restoration Division

## 2.6 EPOXY CRACK-INJECTION MATERIALS

A. Pressure Injection Crack Repair: Two-component 100% solids epoxy crack repair; cap sealer and pressure injection epoxy conforming to ASTM C 881.
   1. Products:
      a. Provide Cap sealer: Sikadur 33; and Injection epoxy: Sikadur Injection Gel; Sika Corporation
      b. Provide Cap sealer: Sto Quick Set Epoxy Gel; and Injection epoxy: Sto Epoxy Binder; Sto Concrete Restoration Division

## 2.7 CORROSION-INHIBITING MATERIALS

A. Corrosion-Inhibiting Treatment: Waterborne solution of alkaline corrosion-inhibiting chemicals for concrete-surface application that penetrates concrete by diffusion and forms a protective film on steel reinforcement.

## 2.8 MISCELLANEOUS MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I, II, or III unless otherwise indicated.

B. Water: Potable.

## 2.9 MIXES

A. General: Mix products, in clean containers, according to manufacturer's written instructions.

B. Dry-Pack Mortar: Mix required type(s) of patching-mortar dry ingredients with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the work required for the removal of the loose and delaminated concrete, the repair and cleaning of the exposed reinforcing steel, the placement of forms, and the placement of repair mortar to minimize the time that reinforcing steel is exposed.

3.2 CONCRETE surface preparation

A. Remove delaminated concrete and remove additional concrete as required to provide minimum required thickness of repair material.

B. Edge Preparation: Make a minimum 1/2" deep sawcut along perimeter of repair areas. Make cut at right angle to surface. Avoid feather edges. Geometric configurations or repair patches shall be kept as simple as possible.

C. After removals and edge conditioning are complete, remove bond inhibiting materials (dirt, concrete slurry, loosely bonded aggregates) by abrasive blasting or high pressure waterblasting with or without abrasive. Check the surfaces after cleaning to insure that surface is free from additional loose aggregate, or that additional delaminations are not present.

D. If hydro demolition is used, cement and particulate slurry must be removed from the prepared surfaces before slurry hardens.

3.3 EXPOSING AND UNDERCUTTING REINFORCING STEEL

A. Remove damaged or unsound concrete. Use concrete removal procedures which will not structurally weaken the surrounding precast concrete.

B. Once initial concrete removal is made, undercut exposed oxidized (corroded) reinforcing. Undercutting shall provide clearance for cleaning, full bar circumference bonding to surrounding concrete, and securing the patch structurally.

C. Provide minimum 3/4" clearance between exposed rebars and surrounding concrete or 1/4" larger than largest aggregate in repair mortar, whichever is greater.

D. Concrete removals shall extend along the bars to locations along the bar free of bond inhibiting corrosion, and where the bar is well bonded to surrounding concrete.

E. If unoxidized reinforcing steel is exposed during the undercutting process, care shall be taken not to damage the bar's bond to surrounding concrete. If bond between bar and concrete is broken, undercutting of the bar shall be required.

F. Any reinforcement which is loose shall be secured in place by tying to other secured bars or by other approved methods.

G. Condition edges of repair area by making 1/2 in. sawcut along perimeter.

## 3.4 REPAIRING AND CLEANING OF REINFORCING STEEL

A. After removal of concrete, notify Architect for inspection of steel reinforcing.

B. If a reinforcing bar has lost more than 20% of its cross section, provide one of the following repair methods:
   1. Completely replace reinforcing, or
   2. Add supplemental reinforcing over the affected section. The new reinforcing bar may be mechanically spliced to the existing bar, or placed parallel to and approximately 3/4" from the existing bar. Lap length shall be in accordance with ACI 318.

C. Remove heavy oxides and scale from the exposed reinforcing bars, as necessary to insure maximum bond of the replacement material.

## 3.5 APPLYING REPAIR MORTAR

A. General: Perform repairs using flowable mortar or non-sag mortar as appropriate to conditions at each location.

B. Forms:
   1. Support, brace, and maintain forms as required to support loads that might be applied. Construct formwork so concrete repair patch is of correct size, shape, and alignment.
   2. Construct forms of one piece and to obtain accurate alignment, location, grades, and plumb work in finished repair.
   3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
   4. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive repair mortar. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Tighten forms and bracing before repair mortar placement to prevent mortar leaks and maintain alignment.

C. Preparation of Form Surfaces:
   1. Coat contact surfaces of forms with a nonresidual, form-coating compound.
   2. Do not allow excess form-coating material to accumulate on forms or to come into contact with existing concrete surfaces against which repair mortar will be placed. Apply in compliance with manufacturer's instructions.

D. Repair Mortar Placement:
   1. Apply bonding compound to prepared concrete and reinforcing steel surfaces. Apply in compliance with manufacturer's instructions at coverage rate recommended for performance as a bonding agent and as a corrosion inhibitor.
   2. Deposit repair mortar continuously in a manner to avoid segregation at its final location and in accordance with manufacturer's instructions.

E. Finish of Formed Surfaces: Provide an as-cast concrete surface to match the existing cast in place concrete surface, with a minimum of seams. Repair and patch defective areas including fins and other projections completely removed and smoothed. Match approved field sample.

F. Curing and Protection: Protect freshly placed repair mortar from premature drying and excessive cold or hot temperatures.

3.6 PENETRATING CRACK SEALER APPLICATION

A. Clean and prepare cracked concrete surfaces in accordance with sealer manufacturer's instructions. Concrete shall be clean, sound, and free of surface moisture, Remove dust, laitance, grease, oils, curing compounds, waxes, impregnations, foreign particles, coatings and disintegrated materials by mechanical means.

B. Apply penetrating crack sealer to cracked concrete surfaces, in accordance with manufacturer's instructions.

3.7 Pressure injection CRACK repair

A. Prepare concrete cracks in accordance with sealer manufacturer's instructions. Cracks and surface 1" on each side of crack shall be clean, sound, and free of surface water (may be damp but not wet). Remove dust, laitance, grease, oils, curing compounds, waxes, impregnations, foreign particles, coatings and disintegrated materials by mechanical means from one inch on each side of crack. Blow cracks clean with oil free compressed air.

B. Mix repair materials according to manufacturer's instructions.

C. Install injection ports. Apply cap seal, trowel grade (non sag) epoxy, to the crack forcing epoxy around the ports and sealing the crack. Allow epoxy to cure before pressure injecting the crack.

D. Pressure inject epoxy into ports to fill crack using pressure injection equipment recommended by epoxy manufacturer.

END OF SECTION 030130

**SECTION 03 30 00**

**CAST-IN-PLACE CONCRETE**

## PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Concrete formwork.

B. Floors and slabs on grade.

C. Concrete reinforcement.

D. Joint devices associated with concrete work.

E. Concrete curing.

1.02 REFERENCE STANDARDS

A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).

B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).

C. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete; 1998 (Reapproved 2004).

D. ACI 301 - Specifications for Structural Concrete; 2016.

E. ACI 302.1R - Guide to Concrete Floor and Slab Construction; 2015.

F. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).

G. ACI 305.1 - Specification for Hot Weather Concreting; 2014.

H. ACI 306.1 - Standard Specification for Cold Weather Concreting; 1998.

I. ACI 308.1 - Specification for Curing Concrete; 2011.

J. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2014(Errata 2017).

K. ACI 347R - Guide to Formwork for Concrete; 2014.

L. ACI SP-66 - ACI Detailing Manual; 2004.

M. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Barsfor Concrete Reinforcement; 2016.

N. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2017.

O. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement; 2014.

P. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2017.

Q. ASTM C172/C172M - Standard Practice for Sampling Freshly Mixed Concrete; 2014a.

R. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field; 2017.

S. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2017b.

T. ASTM C42/C42M - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete; 2016.

U. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2017a.

V. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2015a.

W. ASTM C150/C150M - Standard Specification for Portland Cement; 2017.

X. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2016.

Y. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2016.

Z. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2011.

AA. AASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete; 2017a.

BB. AASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2017.

CC. AASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.

DD. AASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2014.

EE. AASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2016.

FF. AASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2013.

GG. AASTM C1116/C1116M - Standard Specification for Fiber-Reinforced Concrete; 2010a (Reapproved 2015).

HH. AASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2004a (Reapproved 2013).

II. AASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars; 2015.

JJ. AASTM E1155 - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers; 2014.

KK. AASTM E1155M - Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers (Metric); 2014.

LL. AASTM E1643 - Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2011 (Reapproved 2017).

MM. ACRSI (DA4) - Manual of Standard Practice; 2009.

NN. ANSF 61 - Drinking Water System Components - Health Effects; 2017.

OO. ANSF 372 - Drinking Water System Components - Lead Content; 2016.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting at least one week prior to the start of the work of this section.
   1. Ensure required submittals have been provided with sufficient time for review prior to scheduling the Preinstallation Meeting.
   2. Review the detailed requirements for preparing the concrete design mixes and to review the drawings and specifications for this work.
   3. Require attendance by all affected installers, including but not limited to:
      a. Contractor's Superintendent
      b. Laboratory responsible for the concrete design mix
      c. Laboratory responsible for the field quality control
      d. Concrete subcontractor
      e. Architect/Engineer of Record
      f. Board's Authorized Representative
   4. Record minutes and distribute copies within 5 days after meeting to participants, as well as Architect/Engineer of Record, and those affected by decisions made.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. See Section 01 33 29 - LEED Sustainable Design Reporting, when required.

C. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

D. Mix Design: Submit proposed concrete mix design.

1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.

E. Samples for Pigment Color Selection: Submit manufacturer's complete sample chip set, including pigment number and required dosage rate for each color.

F. Sustainable Design Submittals: If any wood or wood-based form materials, including supports, are permanently installed in the project, submit documentation required for sustainably harvested wood as specified in Section 01 60 00 - Product Requirements.

G. Sustainable Design Submittal: If any fly ash, ground granulated blast furnace slag, silica fume, rice hull ash, or other waste material is used in mix designs to replace Portland cement, submit the total volume of concrete cast in place, mix design(s) used showing the quantity of Portland cement replaced, reports showing successful cylinder testing, and temperature on day of pour if cold weather mix is used; use LEED New Product Content Form.

H. Steel Reinforcement Shop Drawings: Submit details of fabrication, bending, and placement, prepared according to ACI SP-66. Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

I. Formwork Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience and a record of successful in-service performance.

B. Manufacturer Qualifications: Company specializing in manufacturing ready-mixed concrete products complying with ASTM C94/C94M. _____

C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

D. Source Limitations: Obtain each type or class of cementitious materials of the same brand from the same manufacturer's plan, each aggregate from one source, and each admixture from the same manufacturer.

E. Perform work of this section in accordance with ACI 301 and ACI 318.

F. Comply with ACI 305.1 when concreting during hot weather.

G. Comply with ACI 306.1 when concreting during cold weather.

1.06 MOCK-UP

A. Construct and erect mock-up panel for integrally colored architectural concrete surfaces .
1. Panel Size: 6 by 6 feet.

2. Locate where directed.

**PART 2 - PRODUCTS**

2.01 FORMWORK

A. Formwork Design and Construction: Comply with guidelines of ACI 347R to provide formwork that will produce concrete complying with tolerances of ACI 117.
   1. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
   2. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.
   3. Chamfer outside corners of beams, joists, columns, and walls.

B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
   1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.
      a. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.
      b. Structural 1, B-B, or better, mill oiled and edge sealed.
      c. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.
   2. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.
   3. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches of concrete surface.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes. Construct paper of fiber tubes of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist plastic concrete loads imposed by concrete without deformation.

D. Form Ties: Removable or snap-off type, galvanized metal or plastic, fixed length, cone type, with waterproofing washer, free of defects that could leave holes larger than 1 inch in concrete surface.
   1. Furnish stainless steel ties where drawings indicate exposed.

E. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
   1. Provide form-release agent with rust inhibitor for steel form-facing materials.

2.02 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).
   1. Type: Deformed billet-steel bars.
   2. Finish: Unfinished, unless otherwise indicated.
   3. Finish: Epoxy coated in accordance with ASTM A775/A775M where indicated.

B. Steel Welded Wire Reinforcement (WWR): Class A epoxy coated, deformed type, ASTM A884/A884M.
   1. Form: Flat Sheets.
   2. WWR Style: As indicated on drawings.

C. Steel Welded Wire Reinforcement (WWR): Plain type, ASTM A1064/A1064M.
   1. Form: Flat Sheets.
   2. WWR Style: As indicated on drawings.

D. Reinforcement Accessories:
   1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch.
   2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
   3. Provide stainless steel, galvanized, plastic, or plastic coated steel components for placement within 1-1/2 inches of weathering surfaces.
   4. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

2.03 CONCRETE MATERIALS

A. Cement: ASTM C150/C150M, Type I - Normal Portland type. Type III cement may be used in lieu of Type I at Contractor's option, when acceptable to the Architect/Engineer of Record.
   1. Acquire cement for entire project from same source.

B. Fine and Coarse Aggregates: ASTM C33/C33M.
   1. Acquire aggregates for entire project from same source.
   2. Class: Severe weathering region, but not less than 3S.
   3. Nominal Maximum Aggregate Size: 3/4 inch, unless otherwise indicated.

C. Lightweight Aggregate: ASTM C330/C330M.
   1. Nominal Maximum Aggregate Size: 3/4 inch, unless otherwise indicated.

D. Fly Ash: ASTM C618, Class C or F.

E. Color Additives: Pure, concentrated mineral pigments specifically intended for mixing into concrete and complying with ASTM C979/C979M.
   1. Color(s): As selected by Architect/Engineer of Record from manufacturer's full range.
   2. Manufacturers:
      a. BRICKFORM; BRICKFORM Liquid Integral Color: www.brickform.com/#sle.
      b. Davis Colors;____: www.daviscolors.com/#sle.
      c. Euclid Chemical Company; COLOR-CRETE: www.euclidchemical.com/#sle.
      d. L.M. Scofield Company; CHROMIX® Admixtures for Color-Conditioned® Concrete: www.scofield.com/#sle.
      e. Solomon Colors; Solomon ColorFlo Liquid Colors: www.solomoncolors.com/#sle.
   3. Provide curing compound for integrally colored concrete per the recommendation of the color additive manufacturer for interior or exterior use as indicated.

F. Water: Potable: ASTM C94/C94M

G. Structural Fiber Reinforcement: ASTM C1116/C1116M.

1. Fiber Type: Carbon Steel Fiber; Type 1, cold drawn wire.
2. Fiber Length: 1.5 inch, nominal.
3. Manufacturers:
   a. Dramix; Bekaert Corporation.
   b. Zorex; Novocon International, Inc.
   c. Fibercon; Fibercon International, Inc..
4. Provide admixtures as recommended by steel fiber manufacturer without increasing specified water-cementitious material ratio.

2.04 ADMIXTURES

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

B. Air Entrainment Admixture: ASTM C260/C260M.

C. High Range Water Reducing Admixture: ASTM C494/C494M Type F.

D. Water Reducing Admixture: ASTM C494/C494M Type A.

2.05 ACCESSORY MATERIALS

A. Underslab Vapor Retarder: Multi-layer plastic extrusion manufactured with polyolefin resins.
   1. Maintain permeance of less than 0.01 Perms as tested in accordance with mandatory conditioning tests per ASTM E1745 Section 7.1 (7.1.1-7.1.5).
   2. Strength: ASTM E1745 Class A.
   3. Thickness: 15 mils minimum
   4. Manufacturers
      a. Basis of Design: Stego Wrap Vapor Barrier (15-mil) by Stego Industries LLC., www.stegoindustries.com. Or equivalent product by:
         1) Griffolyn 65 by Reef Industries, www.reefindustries.com.
         2) Moistop Ultra15 by Fortifiber Building Systems Group. www.fortifiber.com.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
   1. Installation: Comply with ASTM E1643.
   2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.

2.06 BONDING AND JOINTING PRODUCTS

A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.

B. Self-Expanding Strip Waterstops: Bentonite or other hydrophilic material, complying with NSF 61 and NSF 372.
   1. Configuration: Rectangular or trapezoidal strip.
   2. Size: As indicated on drawings; in longest lengths practicable.

3. Manufacturers:
   a. Volclay Waterstop-RX; Colloid Environmental Technologies Co..
   b. Conseal CS-231; Concrete Sealants Inc..
   c. Swellseal Joint; De Neef Construction Chemicals (U.S.) Inc.
   d. Hydrotite; Greenstreak
   e. Mirastop;Mirafi Moisture Protection, Div. of Royal Ten Cate (U.S.), Inc
   f. Adeka Ultra Seal; Mitsubishi International Corporation
   g. Superstop; Progress Unlimited Inc

C. Reglets: Formed steel sheet, galvanized, with temporary filler to prevent concrete intrusion during placement.
   1. Size: 1/4 inch throat, 1 inch deep.

D. ess than 0.0217 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

E. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
   1. Material: ASTM D1752 cork or self-expanding cork (Type III).

2.07 CURING MATERIALS

A. Curing Compound, Non-dissipating: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C309, Type 1, Class B.
   1. Vehicle: Water-based.

B. Moisture-Retaining Sheet: ASTM C171.
   1. Polyethylene film, clear, minimum nominal thickness of 4 mil, 0.004 inch.
   2. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard.

C. Water: Potable, not detrimental to concrete.

2.08 CONCRETE MIX DESIGN

A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

B. Proportioning Structural Lightweight Concrete: Comply with ACI 211.2 recommendations.
   1. Replace as much Portland cement as possible with fly ash, ground granulated blast furnace slag, silica fume, or rice hull ash as is consistent with ACI recommendations.

C. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
   1. For trial mixtures method, employ independent testing agency acceptable to Architect/Engineer of Record for preparing and reporting proposed mix designs.

D. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.

E. Fiber Reinforcement: Add to mix at rate recommended by manufacturer, but not more than 25 pounds per cubic yard.

F. Normal Weight Concrete for Grade beams and Foundation Walls, and Interior Slab-on-Grade:
   1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,000 pounds per square inch, unless noted otherwise
   2. Fly Ash Content: Maximum 25 percent of cementitious materials by weight.
   3. Water-Cement Ratio: Maximum 44 percent by weight.
   4. Total Air Content: For exterior exposed concrete: 6 percent (plus 1 or minus 1.5 percent), determined in accordance with ASTM C173/C173M. Do not air entrain trowel finished interior floors.
   5. Maximum Slump: 4 inches.

G. Structural Normal weight Concrete for Suspended Slabs on Metal Deck:
   1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4000 pounds per square inch.
   2. Water-Cement Ratio: Maximum 50 percent by weight.
   3. Total Air Content: Do not air entrain suspended slabs. Do not allow entrapped air content to exceed 3 percent, determined in accordance with ASTM C173/C173M.
   4. Maximum dry unit weight: 145 lb per cubic foot; plus or minus 3 lb per cubic foot as determined bay ASTM C567.

H. Normal Weight Concrete for Exterior Slab-on-Grade:
   1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 5,000 pounds per square inch, unless noted otherwise
   2. Fly Ash Content: Maximum 25 percent of cementitious materials by weight. For concrete exposed to deicers, limit percentage by weight of cementitious materials other than Portland cement according to ACI 301.
   3. Water-Cement Ratio: Maximum 40 percent by weight.
   4. Total Air Content: 6 percent, determined in accordance with ASTM C173/C173M.
   5. Maximum Slump: 4 inches.

2.09 REINFORCEMENT FABRICATION

A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.

B. Welding of reinforcement is not permitted.

C. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.

D. Locate reinforcing splices not indicated on drawings at point of minimum stress.

E. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the Work:
   1. Bar lengths, depths or bends exceeding specified fabrication tolerances.
   2. Bends or kinks not indicated on the Drawings or final Shop Drawings
   3. Bars with reduced cross section due to excessive corrosion or other cause.
   4. Bars with damaged corrosion resistive coating (if specified).

2.10 MIXING

A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

1. Colored Concrete: Add pigments in strict accordance with manufacturer's instructions to achieve consistent color from batch to batch.
2. Fiber Reinforcement: Batch and mix as recommended by manufacturer for specific project conditions.

B. Transit Mixers: Comply with ASTM C94/C94M, and ASTM C1116/C1116M and furnish batch ticket information.
1. When air temperature is between 85 an 90 deg F, reduce mixing and delivery time from 90 minutes to 75 minutes; when aire temperature is above 90 def F, reduce mixing and delivery time to 60 minutes.

**PART 3 - EXECUTION**

3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.

B. Verify that forms are clean and free of rust before applying release agent.

C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
1. Use latex bonding agent only for non-load-bearing applications.

E. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

F. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.03 ERECTION OF FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.

D. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

E. Provide formed openings where required for items to be embedded in passing through concrete work.

F. Align joints and make watertight. Keep form joints to a minimum.

G. Apply form release agent on formwork in accordance with manufacturer's recommendations.
   1. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.04 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

A. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.

B. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

C. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.

D. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

E. Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.

F. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.

G. Install waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement.

H. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

I. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.05 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Place concrete for floor slabs in accordance with ACI 302.1R.

C. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

D. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

E. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.

F. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.06 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

3.07 SLAB JOINTING

A. Locate joints as indicated on drawings.

B. Anchor joint fillers and devices to prevent movement during concrete placement.

C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.

D. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect/Engineer of Record.
1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
2. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls at not more than 60 feet in any horizontal direction. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

E. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 24 after placing; use 1/8 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.

1. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into 15-foot maximum perpendicular strips, and areas not exceeding 225 square feet.

## 3.08 FLOOR FLATNESS AND LEVELNESS TOLERANCES

A. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
   1. Unless noted otherwise: F(F) of 35; F(L) of 25, on-grade only. with minimum local values of flatness, F(F) 24, and levelness, F(L) 17.
   2. Flooring at Gymnasium, Recording Studios, and other occupancies as noted: F(F) of 50; F(L) of 50 overall; with minimum local values of flatness F(F) 35; and levelness F(L) 35.

B. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155 (ASTM E1155M), within 48 hours after slab installation; report both composite overall values and local values for each measured section.

C. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.

D. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

## 3.09 CONCRETE FINISHING

A. Repair surface defects, including tie holes, immediately after removing formwork.

B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.

C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
   1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
   2. Grout Cleaned Finish: Wet areas to be cleaned and apply grout mixture by brush or spray; scrub immediately to remove excess grout. After drying, rub vigorously with clean burlap, and keep moist for 36 hours.
   3. Cork Floated Finish: Immediately after form removal, apply grout with trowel or firm rubber float; compress grout with low-speed grinder, and apply final texture with cork float.

D. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
   1. Surfaces to Receive Thick Floor Coverings: "Wood float" as described in ACI 302.1R; thick floor coverings include quarry tile, ceramic tile, and Portland cement terrazzo with full bed setting system.
   2. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI 302.1R; thin floor coverings include carpeting, resilient flooring, seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.
   3. Slip-Resistive Aggregate Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

a. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
b. After broadcasting and tamping, apply float finish.
c. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate.

4. Other Surfaces to Be Left Exposed: Trowel as described in ACI 302.1R, minimizing burnish marks and other appearance defects.

E. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

F. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

## 3.10 CURING AND PROTECTION

A. Comply with ACI 308.1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
1. Normal concrete: Not less than seven days.

C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.

D. Surfaces Not in Contact with Forms:
1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than seven days by water ponding, water-fog spray, or saturated burlap.
a. Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for 4 days.
b. Spraying: Spray water over floor slab areas and maintain wet.
c. Saturated Burlap: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides at least 12 inches; maintain in place.
3. Final Curing: Begin after initial curing but before surface is dry.
a. Moisture-Retaining Sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges.
b. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

## 3.11 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.

B. Provide free access to concrete operations at project site and cooperate with appointed firm.

C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.

D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

E. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
   1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cubic yards, but less than 25 cubic yards, plus one set for each additional 50 cubic yards or fraction thereof.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

F. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.

G. Air Content: ASTM C173/C173M for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

H. Concrete Temperature: ASTM A1064/A1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.

I. Unit Weight: ASTM C567/C567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

J. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of five standard cylinder specimens for each composite sample.

K. Compressive-Strength Tests: ASTM C39/C39M
   1. Test two specimens at 7 days, two at 28 days and one at 56 days if 28-day compressive strength has not yet been obtained.
   2. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

L. Floor Flatness and Levelness: ASTM E1155
   1. Test one sample area for each slab area required to have a floor flatness, F(F) or floor levelness F(L) greater than 25.
   2. Perform tests elevated slabs within 72 hours of concrete placement.

M. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

N. Test results shall be reported in writing to Architect/Engineer of Record, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.

O. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect/Engineer of Record but will not be used as sole basis for approval or rejection of concrete.

P. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect/Engineer of Record. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect/Engineer of Record.

Q. Defective Work: Concrete work which does not conform to the specified requirements, including strength, tolerances, and finishes, shall be corrected at the Contractor's expense without extension of time . The Contractor shall also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

3.12 DEFECTIVE CONCRETE

A. Test Results: The testing agency shall report test results in writing to Architect/Engineer of Record and Contractor within 48 hours of test.

B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

C. Repair or replacement of defective concrete will be determined by the Architect/Engineer of Record. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

**END OF SECTION 03 30 00**

**SECTION 04 01 10**

**MASONRY CLEANING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cleaning the following:

1. Unit masonry surfaces.
2. Stone surfaces.

1.3 DEFINITIONS

A. Very Low-Pressure Spray: Less than 100 psi (690 kPa).

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1. Review methods and procedures related to cleaning masonry including, but not limited to, the following:

a. Verify masonry-cleaning equipment and facilities needed to make progress and avoid delays.
b. Materials, material application, and sequencing.
c. Cleaning program.
d. Coordination with building occupants.

1.5 SEQUENCING AND SCHEDULING

A. Work Sequence: Perform masonry-cleaning work in the following sequence:
1. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.
2. Clean masonry surfaces.

B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units according to masonry repair Sections. Patch holes in mortar joints according to masonry repointing Sections.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions and application instructions.
2. Include test data substantiating that products comply with requirements.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For paint-remover manufacturer and chemical-cleaner manufacturer.

B. Preconstruction Test Reports: For cleaning materials and methods.

C. Cleaning program.

1.8 QUALITY ASSURANCE

A. Paint-Remover Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

B. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.

C. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.

D. Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Cleaning: Clean an area approximately 25 sq. ft. for each type of masonry and surface condition.

a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage one or more chemical-cleaner and paint-remover manufacturers to perform preconstruction testing on masonry surfaces.

1. Use test areas as indicated and representative of proposed materials and existing construction.
2. Propose changes to materials and methods to suit Project.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning work to be performed according to product manufacturers' written instructions and specified requirements.

B. Clean masonry surfaces only when air temperature is 40 deg F and above and is predicted to remain so for at least seven days after completion of cleaning.

**PART 2 - PRODUCTS**

2.1 CLEANING MATERIALS

A. Water: Potable.

B. Hot Water: Water heated to a temperature of 140 to 160 deg F.

C. Detergent Solution, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 1/2 cup of laundry detergent, and 20 quarts of hot water for every 5 gal. of solution required.

D. Mold, Mildew, and Algae Remover, Job Mixed: Solution prepared by mixing 2 cups of tetrasodium pyrophosphate (TSPP), 5 quarts of 5 percent sodium hypochlorite (bleach), and 15 quarts of hot water for every 5 gal. of solution required.

E. Nonacidic Gel Cleaner: Manufacturer's standard gel formulation, with pH between 6 and 9, that contains detergents with chelating agents and is specifically formulated for cleaning masonry surfaces.

1. Products: Subject to compliance with requirements, provide one of the following :

a. Dumond Chemicals, Inc.; Safe n' Easy Ultimate Stone and Masonry Cleaner.
b. Price Research, Ltd.; Price Marble Cleaner-Gel.
c. PROSOCO, Inc.; Sure Klean 942 Limestone & Marble Cleaner.

F. Nonacidic Liquid Cleaner: Manufacturer's standard mildly alkaline liquid cleaner formulated for removing mold, mildew, and other organic soiling from ordinary building materials, including polished stone, brick, aluminum, plastics, and wood.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABR Products, Inc.; Building Wash 3.
b. Cathedral Stone Products, Inc.; D/2 Biological Solution.
c. Diedrich Technologies Inc., a division of Sandell Construction Solutions; Diedrich 910PM Polished Marble/Granite Cleaner.
d. Dumond Chemicals, Inc.; Safe n' Easy All Purpose Cleaner
e. Hydrochemical Techniques, Inc.; HydroClean HT-700 Polished Marble & Granite Cleaner.
f. Price Research, Ltd.; Price Non-Acid Masonry Cleaner.
g. PROSOCO, Inc.; Stand Off All Surface Cleaner.

2.2 ACCESSORY MATERIALS

A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABR Products, Inc.; ABR Rubber Mask.
b. Price Research, Ltd.; Price Mask.
c. PROSOCO, Inc.; Sure Klean Strippable Masking.

2.3 CHEMICAL CLEANING SOLUTIONS

A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.

**PART 3 - EXECUTION**

3.1 PROTECTION

A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent paint removers and chemical cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.

1. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents according to manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.

2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
3. Neutralize alkaline and acid wastes before disposal.
4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

B. Remove gutters and downspouts and associated hardware adjacent to immediate work area and store during masonry cleaning. Reinstall when masonry cleaning is complete.

1. Provide temporary rain drainage during work to direct water away from building.

3.2 CLEANING MASONRY, GENERAL

A. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 20 feet away by Architect.

B. Proceed with cleaning in an orderly manner; work from top to bottom of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.

C. Use only those cleaning methods indicated for each masonry material and location.

1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.

a. Equip units with pressure gages.
b. For chemical-cleaner spray application, use low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with nozzle having a cone-shaped spray.
c. For water-spray application, use fan-shaped spray that disperses water at an angle of 25 to 50 degrees.
d. For heated water-spray application, use equipment capable of maintaining temperature between 140 and 160 deg F (60 and 71 deg C) at flow rates indicated.

D. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.

E. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.

F. Water Application Methods:

1. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 6 inches (150 mm) from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.

G. Chemical-Cleaner Application Methods: Apply chemical cleaners to masonry surfaces according to chemical-cleaner manufacturer's written instructions; use brush or spray application. Do not spray apply at pressures exceeding 50 psi. Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

H. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.

1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.

I. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

## 3.3 PRELIMINARY CLEANING

A. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.

1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.
2. Remove paint and calking with alkaline paint remover

a. Comply with requirements in "Paint Removal" Article.
b. Repeat application up to two times if needed.

3. Remove asphalt and tar with solvent-type paste paint remover.

a. Comply with requirements in "Paint Removal" Article.
b. Apply paint remover only to asphalt and tar by brush without prewetting.
c. Allow paint remover to remain on surface for 10 to 30 minutes.
d. Repeat application if needed.

## 3.4 CLEANING MASONRY

A. Cold-Water Soak:

1. Apply cold water by intermittent spraying to keep surface moist.

2. Use perforated hoses or other means that apply a fine water mist to entire surface being cleaned.
3. Apply water in cycles of five minutes on and 20 minutes off.
4. Continue spraying until surface encrustation has softened enough to permit its removal by water wash, as indicated by cleaning tests for 72 hours.
5. Remove soil and softened surface encrustation from surface with cold water applied by low-pressure spray.

B. Cold-Water Wash: Use cold water applied by low-pressure spray.

C. Hot-Water Wash: Use hot water applied by low-pressure spray.

D. Detergent Cleaning:

1. Wet surface with hot water applied by low-pressure spray.
2. Scrub surface with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that surface remains wet.
3. Rinse with hot water applied by low-pressure spray to remove detergent solution and soil.
4. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

E. Mold, Mildew, and Algae Removal:

1. Wet surface with hot water applied by low-pressure spray.
2. Apply mold, mildew, and algae remover by brush or low-pressure spray.
3. Scrub surface with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that surface remains wet.
4. Rinse with hot water applied by low-pressure spray to remove mold, mildew, and algae remover and soil.
5. Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

F. Nonacidic Gel Chemical Cleaning:

1. Wet surface with hot water applied by low-pressure spray.
2. Apply gel cleaner in 1/8-inch thickness by brush, working into joints and crevices. Apply quickly and do not brush out excessively, so area is uniformly covered with fresh cleaner and dwell time is uniform throughout area being cleaned.
3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer.
4. Remove bulk of gel cleaner.
5. Rinse with hot water applied by low-pressure spray to remove chemicals and soil.
6. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

G. Nonacidic Liquid Chemical Cleaning:

1. Wet surface with hot water applied by low-pressure spray.
2. Apply cleaner to surface in two applications by brush or low-pressure spray.
3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer.
5. Rinse with hot water applied by low-pressure spray to remove chemicals and soil.
6. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once. If additional cleaning is required, use steam cleaning.

3.5 FINAL CLEANING

A. Clean adjacent nonmasonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.

B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

C. Remove masking materials, leaving no residues that could trap dirt.

3.6 FIELD QUALITY CONTROL

A. The CHA's Designated Representative will perform inspections. Allow the CHA's Designated Representative use of lift devices and scaffolding, as needed, to perform inspections.

B. The Architect's responsibilities at the site include observing progress and quality of portion of the Work completed. Allow Architect use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

C. Notify the CHA's Designated Representative and the Architect in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until the CHA's Designated Representative and Architect have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

D. Manufacturer's Field Service: Engage chemical-cleaner manufacturer's factory-authorized service representatives for consultation and Project-site inspection, to perform preconstruction product testing, and provide on-site assistance when requested by Architect. Have -cleaner manufacturer's factory-authorized service representatives visit Project site not less than twice to observe progress and quality of the Work.

**END OF SECTION**

**SECTION 04 01 20.63**

**BRICK MASONRY REPAIR**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Repairing brick masonry.
2. Removing abandoned anchors.
3. Painting steel uncovered during the work.

B. Related Requirements:

1. Section 01 35 16 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.

1.3 DEFINITIONS

A. Low-Pressure Spray: 100 psi**;** 4gpm.

B. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.

C. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of bricks to freezing and thawing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1. Review methods and procedures related to brick masonry repair including, but not limited to, the following:

a. Verify brick masonry repair specialist's personnel, equipment, and facilities needed to make progress and avoid delays.

b. Materials, material application, sequencing, tolerances, and required clearances.
c. Quality-control program.
d. Coordination with building occupants.
e. Construction schedule.
f. Staging schedule.
g. Façade access to the work area by the CHA's Designated Representative and Architect to occur throughout the project.
h. Shop drawings
i. Mockups of masonry and masonry repairs

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacture's specifications and installation instructions for each masonry materials, reinforcing ties, anchors, flashing and miscellaneous accessories specified. recommendations for product application and use.
2. Test Report: Include test data substantiating that products comply with requirements.

B. Samples for Initial Selection: For the following:

1. Colored Mortar: Submit sets of mortar that will be left exposed in the form of sample mortar strips, 6 inches (150 mm) long by 1/4 inch (6 mm) wide, set in aluminum or plastic channels.

a. Have each set contain a close color range of at least three. Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.

2. Sand Types Used for Mortar: Minimum 8 oz. (240 mL) of each in plastic screw-top jars.
3. Include similar Samples of accessories involving color selection.

C. Samples for Verification: For the following:

1. Each type of brick unit to be used for replacing existing units. Include sets of Samples to show the full range of shape, color, and texture to be expected. For each brick type, provide straps or panels containing at least five bricks. Include multiple straps for brick with a wide range.
2. Accessories: Each type of accessory and miscellaneous support.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For brick masonry repair specialist including field supervisors and workers and testing service.

B. Preconstruction Test Reports: For replacement bricks.

C. Quality-control program.

1.7 QUALITY ASSURANCE

A. Brick Masonry Repair Specialist Qualifications: Engage an experienced brick masonry repair firm to perform work of this Section. Firm shall have completed ten (10) years of experience similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repair work.

1. Field Supervision: Brick masonry repair specialist firm shall maintain experienced full-time supervisors on Project site during times that brick masonry repair work is in progress. Field Supervisor should have a minimum 10 years of experience with brick masonry repair.

B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

C. Mockups: Prepare mockups of brick masonry repair to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.

1. Masonry Repair: Prepare sample areas for each type of masonry repair work performed. If not otherwise indicated, size each mockup not smaller than 4 feet by 4 feet. Construct sample areas in locations in existing walls where directed by Architect unless otherwise indicated. Demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:

a. Bond Pattern
b. Replacement brick
c. Mortar color and tooling
d. Expansion Joint Detail
e. Caulk Color
f. Anchorage
g. Flashing and weeps.
h. Cavity cleaning and protection.
i. Other built-in components.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on brick masonry as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Replacement Brick: Test each proposed type of replacement brick according to sampling and testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, modulus of rupture, efflorescence, initial rate of absorption, and freeze and thawing (If required to verify conformance with ASTM C216 and/or product specification. Test bricks as requested by A/E per ASTM C151, for coefficient of linear moisture expansion.

3. Existing Brick: Test each type of existing masonry unit indicated for replacement according to testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove two existing units from locations designated by Architect. Take testing samples from these units.
4. Existing Mortar: Test according to ASTM C 295/C 295M, modified as agreed by testing service and Architect for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.

B. Manufacturer to test helical anchors at a minimum of 1 test per 1000 total anchors. Provide minimum of 2 tests per backup material and face masonry material embedded into. Submit testing information to Architect for review.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver bricks to Project site strapped together in suitable packs or pallets or in heavy-duty cartons and protected against impact and chipping.

B. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.

E. Store sand where grading and other required characteristics can be maintained and contamination avoided.

F. Handle bricks to prevent overstressing, chipping, defacement, and other damage.

G. Protect all materials from physical damage, rain, snow, groundwater and from soilage or contamination by other deleterious materials that may cause staining or other defects.

H. Protect masonry from freezing when outside air temperature is lower than 40 degrees F.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed according to product manufacturers' written instructions and specified requirements.

B. Temperature Limits: Repair brick masonry only when air temperature is between 40 and 90 deg F and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.

C. Cold-Weather Requirements: Comply with BIA Technical Note 1 and the following procedures for masonry repair and mortar-joint pointing unless otherwise indicated:

1. When mean daily air temperature is below 40 deg F, provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for seven days after repair.

D. Hot-Weather Requirements: Protect masonry repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F and above unless otherwise indicated.

E. For manufactured repair materials, perform work within the environmental limits set by each manufacturer

F. Do not use frozen materials or materials mixed or coated with ice or frost.

G. Take proper procedure to protect masonry work from collapse, deterioration and damage.

H. Repair damaged or defective work to the satisfaction of the Architect.

I. Protection of Work

1. Protect masonry, masonry accessories, flashing and other related materials during storage and construction from damage, soilage or other deleterious circumstances.
2. Protect partially completed work against weather and when work is not in progress, included but not limited to:

a. Cover tops of walls with strong, waterproof, non-staining membrane.
b. Extend covering down 24 inches on all sizes.
c. Anchor members securely.

3. Prevent mortar from staining the face of masonry to be left exposed.

a. Immediately remove mortar in contact with the finished surfaces of existing work.

J. Where masonry construction is indicated on Drawings or required by code to have a fire resistant construction, provide masonry materials and methods in manner to obtain the necessary rating.

K. Repairs masonry construction where required due to damage or defective Work and where required to accommodate Work of other trades, in an approved manner so that patching is not visually apparent.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain each type of material for repairing brick masonry (brick, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MASONRY MATERIALS

A. Face Brick: As required to complete brick masonry repair work.

1. Physical Properties: According to ASTM C216 and as follows:

a. Classification: Grade SW, Type FBS
   1) Compressive Strength: 5,000 psi minimum average
   2) Five-hour Boiling Absorption: 17% max. (average of 5 bricks).
   3) Saturation Coefficient: 0.78 maximum

      a) The absorption alternate in ASTM 216 shall not be allowed unless specifically approved by the Architect.

   4) Initial Rate of Absorption: between 5 and 25 grams per 30 square inches per minute.
   5) Efflorescence: brick rated as "not efflorescent" per ASTM C67

b. Size: To match existing sizes.
c. Color and Texture: to match existing cleaned masonry to the satisfaction of Architect and CHA.
d. End bricks used for headers shall match sides
e. Bricks with bed faces exposed shall be solid.
f. For existing brickwork that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range and variation rather than brick that matches an individual color within that range.

2.3 MORTAR MATERIALS

A. See Section 04 01 20.64 “Brick Masonry Repointing”.

2.4 REINFORCING, ANCHORS, AND TIES

A. Joint Reinforcing: ASTM A82 and ASTM A153-B2
   1. Ladder Type
   2. Gauge: Min. No. 9 gauge deformed side rods with No. 9 gauge cross rods at

max. 16" center to center.

3. Width: 1 1/2" to 2" less than walker thickness.
4. Finish: Stainless Steel, Type 304 or 316

B. Adjustable Veneer Assemblies: ASTM A82 and ASTM A153-B2

1. Wall Plate: Min. 14 Gauge
2. Anchor Wire: Min. 3/16-inch
3. Finish: Stainless Steel, Type 304 or 316
4. Acceptable Products:

   a. HOH HB-200 Adjustable veneer anchor.

C. Joint Stabilizing Anchors (to bridge expansion joints): ASTM A82 and ASTM A153-B2

1. Construction: Double plate construction joined by 2,9 gauge wire shafts.
2. Length: 12-inches
3. Finish: Stainless Steel, Type 304 or 316
4. Acceptable Products:
   a. HOH HB-200 Adjustable veneer anchor.

D. Corrugated ties are not acceptable.

2.5 STABILIZATION ANCHORS

A. Helical Ties

1. Material: Type 304 stainless steel
2. Diameter: 8mm/10mm
3. Length: Insert Length= Facade thickness + cavity + required penetration to back-up
4. Acceptable Product:

   a. Helifix; Dry fix

2.6 COATINGS

A. Coating of embedded steel surfaces, including steel structural lintels and shelf angles:

1. Polyamidoamine Epoxy

   a. Acceptable Products:

      1) Tnemec; Series 135 - 4-6 mils
      2) Sherwin Williams; Macroproxy 646 FC - 5-10 Mils

B. Coating of exposed structural carbon steel:

1. Primer:

   a. Acceptable Products:

      1) Tnemec; Series 135 - 4-6 mils
      2) Sherwin Williams; Macroproxy 646 FC - 5-10 mils

2. Finish

   a. Acceptable Products:

      1) Tnemec; Series 750 UVX - 3 mils
      2) Sherwin Williams; Hi-Solids Polyurethane - 3-5 mils

2.7 SEALANT AND BACKER ROD

A. See Section 07 92 00 “Joint Sealants”.

2.8 FLASHING

A. Membrane Flashing: ASTM D412 and ASTM D822

1. Material: Rubberized Asphalt
2. Acceptable Products:
   a. Hohmann & Barnard; Flex-Flash
   b. GCP Applied Technologies; Perm-A-Barrier Wall Flashing
   c. York flashings; York Seal

B. Sheet Metal Flashing: ASTM A167

1. Material: Stainless Steel, Type 304 or 316
2. Thickness: 24-Gage
3. Finish Mill rolled No. 2B
4. Profile: Brake-formed to profile shown drawings.

C. Unitized Flashing/ Drainage system:

1. Basis of Design: 45-Mil membrane of EPDM rubber, 1/4" x 10" Mortar net with drainage mat and 28 gauge, 304 stainless steel drip edge, high strength corrosion and UV resistant plastic termination bar and integral no clog weep taps.
2. Acceptable Product:

   a. Mortar Net Solutions: Total Flash Cavity Wall Drainage system.

2.9 ACCESSORY MATERIALS

A. Expansion Joint Filler: ASTM D1065, Class RE41

1. Material: Closed cell neoprene
2. Thickness (vertical): 1/2 inch for expansion joints
3. Thickness (horizontal): 1/4 inch for soft joints.
4. Compressibility: 50% minimum

B. Wicks: Cotton sash cord, 3/8 inch diameter, in length required to produce 2 inch exposure on exterior and 18 inch cavity or ? vents to match color/ mortar

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C. Drip Edge: 26 Gage, factory-formed hemmed edge, stainless steel (Type 304)

D. Termination Bar: 26 gage x 1 1/2 inches wide with flange on top to receive sealant and 1/4 inch diameter holes at 8 inches on center, stainless steel (Type 304). Anchor with stainless steel screw type masonry anchors.

E. Setting Buttons and Shims: Resilient plastic, nonstaining to masonry, sized to suit joint thicknesses and bed depths of bricks, less the required depth of pointing materials unless removed before pointing.

F. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

G. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Minimal possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could leave residue on surfaces.

## PART 3 - EXECUTION

### 3.1 PROTECTION

A. Prevent mortar from staining face of surrounding masonry and other surfaces.

1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

B. Remove gutters and downspouts and associated hardware adjacent to masonry and store during masonry repair. Reinstall when repairs are complete.

1. Provide temporary rain drainage during work to direct water away from building.

### 3.2 MASONRY REPAIR, GENERAL

A. Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from 20 feet away by Architect.

### 3.3 ABANDONED ANCHOR REMOVAL

A. Remove abandoned anchors, brackets, wood nailers, and other extraneous items no longer in use unless indicated to remain.

1. Remove items carefully to avoid spalling or cracking masonry.
2. Notify Architect before proceeding if an item cannot be removed without damaging surrounding masonry. Do the following where directed:

    a. Cut or grind off item approximately 3/4 inch beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
    b. Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.

3. Patch hole where each item was removed unless directed to remove and replace bricks.

## 3.4 BRICK REMOVAL AND REPLACEMENT

A. At locations indicated, remove bricks that are damaged, spalled, or deteriorated or are to be reused. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.

1. When removing single bricks, remove material from center of brick and work toward outside edges.

B. Support and protect remaining masonry that surrounds removal area.

**C.** Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition. Coordinate with new flashing, reinforcement, and lintels, which are specified in other Sections, where occur**.**

D. Notify Architect of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.

E. Remove in an undamaged condition as many whole bricks as possible.

1. Remove mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.
2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
3. Store brick for reuse. Store off ground, on skids, and protected from weather.
4. Deliver cleaned brick not required for reuse to CHA unless otherwise indicated.

F. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for brick replacement.

G. Replace removed damaged brick with other removed brick in good condition, where possible, or with new brick matching existing brick. Do not use broken units unless they can be cut to usable size.

H. Install replacement brick into bonding and coursing pattern of existing brick, use whole units wherever possible. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.

1. Maintain joint width for replacement units to match existing joints.
2. Use setting buttons or shims to set units accurately spaced with uniform joints.

I. Construct masonry aligned, plumb and true making level courses:

1. Maximum variation from level for lintel and other conspicuous lines:

a. 1/4 inch in any direction.
b. 1/2 inch in 40 feet.

2. Where fresh masonry joints partially set or existing masonry:

a. Remove loose brick and mortar to "sawtooth" new brick with existing without damaging adjacent sound brick.

b. Dampen existing masonry to receive new mortar, but brick should not have surface water.

3. Rebuilt areas within existing areas shall blend and match surfaces of remaining masonry.

J. Expansion Joints: Minimum 1/2 inch wide, unless otherwise specified

1. Use compressible joint filler and maintain joints free of mortar or other debris that would prevent proper movement of the joint.

K. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter ends with enough mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.

1. Remove masonry units disturbed after laying, clean and reset with fresh mortar.
2. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.

3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.

L. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

## 3.5 REINFORCING AND ANCHORAGE

A. Provide joint reinforcement in horizontal joints at 16 inches center to center, end-lapped 6-inches min. interrupted only where control and expansion joints are required.

B. Install anchors and ties in accord with manufacturers recommendations:

1. Maximum spacing for veneer anchors: 24 inches horizontally, 16 inches vertically.
2. Embed ties at least 2 inch in horizontal joints.

## 3.6 PAINTING STEEL UNCOVERED DURING THE WORK

A. All existing steel exposed and accessible during the course of work is to be cleaned to the extent required by the coating manufacturer and as indicated below, primed, and painted including but not limited to: shelf angles, structural beams, lintels, and masonry anchorage.

B. Inspect surfaces to be finished and the conditions of the building before starting the work. Report to the Architect any defects that render any area or item unfit to receive finish. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than 1/16 inch, notify Architect before proceeding.

C. Prepare and paint all existing lintel, shelf angles, spandrel beams, brackets, clip angles, and columns it as follows

1. Surface Preparation: Remove loose mill scale, weld splatter, paint, rust, and other surface contaminants according to SSPC-SP 3, "Power Tool Cleaning, as applicable to comply with paint manufacturer's recommended preparation.
2. Immediately paint exposed steel following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat)

## 3.7 FLASHING INSTALLATION

A. Install flashing in continuous bands in accord with manufacture's recommendations:

1. Provide minimum 4-inch lap, seal with mastic approved by manufacture.
2. Terminate flashing at upper edge with continuous stainless-steel termination bars and Termination bar shall be installed with a continuous flange and be caulked with a continuous bead od sealant.
3. Fully adhere flashing without gaps bubbles or fishmouths.

B. Provide end dams at all flashing terminations.

C. Form membrane to correct profile without wrinkles or buckles:

1. Carefully fit flashing around projections.
2. Protect flashing from puncture applying mastic or sealant over sharp projections.

D. Mechanically anchor top edge of flashing with termination bar. seal top edge.

E. Install sealant or mastic around anchors or ties that penetrate the flashing.

F. Protect flashing from tears, punctures, and other damage.

G. Provide stainless steel drip edge lip at bottom of flashing, extend min. 1/2 inch from face of wall unless otherwise specified.

## 3.8 FINAL CLEANING

A. Clean masonry surfaces only when air temperatures is 40 degrees F and above and is predicted to remain so for at least 7 days after completion of cleaning.

B. Clean new masonry and mortar areas to remove dirt and mortar residue and debris 24 to 48 hours after installation.

C. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

D. Wash masonry surfaces with mild, non-staining masonry cleaner.

1. Protect adjacent surfaces from damage
2. Use cleaning solution per manufactures written instructions. Use stiff fiber brushes to scrub wall area.
3. Thoroughly rinse walls with clean water applied by low pressure spray 100-400 psi or 4-6 gallons per minute to remove mortar, dirt, debris, and cleaning solution.

E. Clean adjacent non-masonry surfaces. Use detergent and soft brushes or cloths.

F. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

G. Remove masking materials, leaving no residues that could trap dirt.

3.9 FIELD QUALITY CONTROL

A. The CHA's Designated Representative will perform inspections. Allow the CHA's Designated Representative use of lift devices and scaffolding, as needed, to perform inspections.

B. The Architect's responsibilities at the site include observing progress and quality of portion of the Work completed. Allow Architect use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

C. Notify the CHA's Designated Representative and the Architect in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until the CHA's Designated Representative and Architect have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

3.10 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property.

B. Masonry Waste: Remove masonry waste and legally dispose of off CHA's property in accordance with Section 01 74 19 "Construction Waste Management and Disposal".

**END OF SECTION**

**SECTION 04 01 20.64**

**BRICK MASONRY REPOINTING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Repointing joints with mortar.

B. Related Requirements:

1. Section 01 35 16 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.

1.3 DEFINITIONS

**A.** Low-Pressure Spray: 100 psi**;** 4 gpm**.**

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1. Review methods and procedures related to repointing brick masonry including, but not limited to, the following:

a. Verify brick masonry repointing specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
b. Materials, material application, sequencing, tolerances, and required clearances.
c. Quality-control program.
d. Coordination with building occupants.
e. Construction schedule.
f. Staging schedule.
g. Façade access to the work area by the CHA's Designated Representative and Architect to occur throughout the project.
h. Mockups of masonry of masonry repairs

## 1.5 SEQUENCING AND SCHEDULING

A. Work Sequence: Perform brick masonry repointing work in the following sequence, which includes work specified in this and other Sections:

1. Remove plant growth.
2. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Clean masonry.
4. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
5. Repair masonry, including replacing existing masonry with new masonry materials.
6. Rake out mortar from joints to be repointed.
7. Point mortar and sealant joints.
8. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.

B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Replace bricks according to Section 04 01 20.63 "Brick Masonry Repair." Patch holes in mortar joints according to "Repointing" Article.

## 1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Manufacture's standard data including product application and use.
3. Performance data substantiating that products comply with requirements.

B. Samples for Initial Selection: For the following:

1. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
    a. Have each set contain a close color range of at least six. Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
    b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.
2. Sand Type Used for Pointing Mortar: Minimum 8 oz. of each in plastic screw-top jars.
3. Sealant materials.
4. Include similar Samples of accessories involving color selection.

C. Samples for Verification: For the following:

1. Each type, color, and texture of pointing mortar in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.

a. Include with each Sample a list of ingredients with proportions of each. Identify sources, both supplier and quarry, of each type of sand and brand names of cementitious materials and pigments if any.
b. Each set shall contain a close range of six samples.

2. Sealant materials.
3. Accessories: Each type of accessory and miscellaneous support.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For brick masonry repointing specialist.

B. Preconstruction Test Reports: For production mortar, existing masonry units and existing mortar.

1.8 QUALITY ASSURANCE

A. Brick Masonry Repointing Specialist Qualifications: Engage an experienced brick masonry repointing firm to perform work of this Section. All work shall be performed by workers experienced in the handling and setting of the material have not less than ten (10) years satisfactory experience in comparable restoration work, including work on a minimum of five (5) projects similar in scope and scale to this project. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repointing work.

B. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.

C. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

D. Mockups: Prepare mockups of brick masonry repointing to demonstrate aesthetic effects and to set quality standards for materials and execution. No work shall be performed in the work area until the mock-up is completed by the contractor and approved by the Architect and/or the CHA's Designated Representative.

1. Provide sample of repointing in an area designated by Architect and/or the CHA's Designated Representative.
2. Sample must be cleaned prior to review by Architect and/or the CHA's Designated Representative.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.

D. Store sand where grading and other required characteristics can be maintained and contamination avoided.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed according to product manufacturers' written instructions and specified requirements.

B. Cold-Weather and Hot-Weather Procedures: Comply with BIA, Brick Industry Association, "Technical notes on Brick Construction" or ACI 530/530.1/ERTA, whichever is more stringent.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. D

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg.F. and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. C

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain each type of material for repointing brick masonry (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or Type II, white, gray, or both as required for color matching of mortar.

B. Hydrated Lime: ASTM C 207, Type S, containing no air entrainment.

C. Aggregate for Masonry Mortar: ASTM C 144.

1. For mortar exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch (6mm) thick, use aggregate graded with 100% passing No. 16 (1.18mm) sieve.
3. For joints less than 3/8 inch thick (9.5 mm) or less, use aggregate graded 100% passing for No. 8 sieve and 95% passing No. 16 sieve.
4. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match. Color: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.

D. Air-Entraining Admixtures: not acceptable.

E. Masonry Cement is not acceptable

F. Admixtures: not acceptable.

G. Mortar Pigments: ASTM C 979, Inorganic compounds used in the proportions recommended by the manufacture, but no case exceeding 10% of the weight of the cement, carbon black shall not exceed 2% of the weight of the cement.

H. Water: Potable.

## 2.3 ACCESSORY MATERIALS

A. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

B. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.
2. Minimal possibility of damaging exposed surfaces.
3. Consistency of each application.
4. Uniformity of the resulting overall appearance.
5. Do not use products or tools that could leave residue on surfaces.

## 2.4 MORTAR MIXES

A. General: Do not use admixtures, air-entraining agents, accelerators, retarders, water-repellent agents, anti-freeze compounds, or other admixtures unless otherwise indicated.

1. Do not use frozen materials mixed or coated with ice or frost.
2. Do not use calcium chloride in mortar
3. Mortar shall match original mortar in color, texture, variation and aggregate size. Do no match previous repointing or repair mortars unless otherwise specified.

4. Replacement mortar shall be within range of properties, established by pre-construction testing and approved by the Architect and the CHA's Designated Representative.

B. Preconstruction mortar testing shall be used to determine mortar type and properties.

C. Pointing Mortar by Type: ASTM C 270 and ASTM C1329, Proportion Specification, Type N unless otherwise indicated;

1. Mortar properties subject to revision per results of pre-construction testing of existing mortar and masonry units.
2. Average compressive strength (3 cubes) at 28 days:1100-1800psi
3. Air Content: to be in range 8% to 17% by volume.
4. Water Retention: Minimum 70% of original flow.

2.5 MORTAR MIXING

A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials thoroughly in a clean, mechanical batch mixer, in accordance with ASTM C270 and in quantities need for immediate use.

B. Retempering: If water is lost by evaporation, re-temper only within two hours of mixing

C. Maintain sand uniformly damp immediately before the mixing process.

D. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment to cement ratio; mix in accordance with manufacturer's instructions, uniform in coloration.

E. Do not use anti-freeze compounds to lower freezing point of mortar.

**PART 3 - EXECUTION**

3.1 PROTECTION

A. Prevent mortar from staining face of surrounding masonry and other surfaces.

1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
2. Keep wall area wet below pointing work to discourage mortar from adhering.
3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

B. Remove gutters and downspouts and associated hardware adjacent to masonry and store during masonry repointing. Reinstall when repointing is complete.

1. Provide temporary rain drainage during work to direct water away from building.

C. Comply with all City of Chicago ordinances and regulations regarding, but not limited to, noise and dust mitigation to surrounding areas.

D. Provide and maintain means to prevent the spread to dust and excessive noise within the building.

E. Provide erect and maintain temporary barricades and security devices.

3.2 MASONRY REPOINTING, GENERAL

A. Appearance Standard: Repointed surfaces are to have a uniform appearance as viewed from 20 feet away by Architect.

3.3 REPOINTING

1. Remove mortar in defective joints in areas indicated by the drawings or as designated by the Architect.
    a. Defective mortar shall be removed to a uniform depth to sound mortar, but no less than 3/4" deep.
    b. Remove mortar from open, cracked and powdering joints.
2. Fully clean and cut-out joints to surface of masonry units
3. Remove dirt and dust with low pressure water:
    a. Alternate dust removal techniques must be reviewed by the Architect and CHA.
4. Do not spall edges of brick or other masonry units or widen joints.

B. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.

C. Installation

1. Repointing mortar prehydration: Thoroughly mix all dry ingredients. Mix again adding only enough water to produce a damp consistency which will retain its form when pressed into a ball. Maintain mortar in dampened condition for 1-1 1/2 hours, to prehydrate the mortar. Add enough water to bring it to proper consistency-somewhat drier than conventional setting mortar.
2. Dampen Joints just prior to repointing, do not wet beyond saturation.
3. Fill all deep voids in joints with mortar even with surface of existing mortar in prepared joints.
4. Apply mortar in thin layers 1/4 inch max. per layer until joints are completely filled. Allow each layer to become thumbprint hard before applying next layer.
5. Compact mortar with a tool to a smooth finish, tight to brick edges.
    a. Joint characteristics shall blend with adjoining existing work.
6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

D. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

3.4 FINAL CLEANING

A. Clean masonry surfaces only when air temperature is 40 degrees F and above and is predicted to remain so for at least 7 days after completion of cleaning.

B. Clean new masonry and mortar areas to remove dirt and mortar residue and debris 24 to 48 hours after installation.

C. Remove masking material leaving no residue that could trap dirt.

D. Thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.

1. Do not use metal scrapers, towels or brushes.
2. Do not use acidic or alkaline cleaners.

E. Wash masonry surfaces with mild, non-staining masonry cleaner:

1. Protect adjacent surfaces from damage.
2. Use cleaning solution per manufactures written instructions. Use stiff fiber brushes to scrub wall area.
3. Thoroughly rinse walls with clean water applied by low pressure spray 100-400 psi or 4-6 gallons per minute to remove mortar, dirt, debris, and cleaning solution.

F. Clean adjacent non-masonry surfaces. Use detergent and soft brushes or cloths.

G. Clean mortar and debris from surrounding areas and roof; remove debris from drains, gutters and downspouts. Rinse off roof and flush gutters and downspouts.

3.5 FIELD QUALITY CONTROL

A. The CHA's Designated Representative will perform inspections. Allow the CHA's Designated Representative use of lift devices and scaffolding, as needed, to perform inspections.

B. The Architect's responsibilities at the site include observing progress and quality of portion of the Work completed. Allow Architect use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

C. Notify the CHA's Designated Representative and the Architect in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until the CHA's Designated Representative and Architect have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

**END OF SECTION**

**SECTION 04 20 00**

**UNIT MASONRY**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Pre-faced concrete masonry units.
3. Clay face brick.
4. Glazed brick.
5. Structural clay facing tile.
6. Mortar and grout.
7. Steel reinforcing bars.
8. Masonry-joint reinforcement.
9. Ties and anchors.
10. Embedded flashing.
11. Miscellaneous masonry accessories.

B. Products Installed but not Furnished under This Section:

1. Cast-stone trim in unit masonry.
2. Steel lintels in unit masonry.
3. Steel shelf angles for supporting unit masonry.
4. Cavity wall insulation.

C. Related Requirements:

1. Section 07 62 00 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
2. Section 09 75 19 "Stone Trim" for stone window stools.
3. Section 32 14 00 "Unit Paving" for exterior unit masonry paving.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

C. Samples for Verification: For each type and color of the following:

1. Pre-faced CMUs.
2. Clay face brick, in the form of straps of five or more bricks.
3. Special brick shapes.
4. Glazed brick.
5. Glazed structural clay tile.
6. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.
b. For exposed brick, include test report for efflorescence according to ASTM C 67.
c. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing according to ASTM C 67.

2. Integral water repellent used in CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.

8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

## 1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockup as shown on Drawings.
2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
3. Clean exposed faces of mockups with masonry cleaner as indicated.
4. Protect accepted mockups from the elements with weather-resistant membrane.
5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

    a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
    b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe, and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

### 2.2 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

B. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

### 2.3 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units and where indicated.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514/E 514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ACM Chemistries.
2) BASF Corporation.
3) Euclid Chemical Company (The); an RPM company.
4) GCP Applied Technologies Inc.

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa), unless otherwise indicated.
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less than nominal dimensions.

D. Pre-faced CMUs: Lightweight hollow concrete units complying with ASTM C 90, with manufacturer's standard smooth resinous facing complying with ASTM C 744.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Trenwyth Industries, Inc., Astra Glaze.
   b. The Burns & Russell Co., Spectra Glaze.
   c. Premier Block Corp.

2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa), unless otherwise indicated.
3. Size: Manufactured to dimensions specified in "CMUs" Paragraph but with pre-faced surfaces having 1/16-inch- (1.5-mm-) wide returns of facing to create 1/4-inch- (6.5-mm-) wide mortar joints with modular coursing.
4. Colors and Patterns: As selected by Architect from manufacturer's full range.

## 2.4 **CONCRETE AND MASONRY** LINTELS

A. General: Provide one of the following:

1. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.
2. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete," and with reinforcing bars indicated.
3. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

## 2.5 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.

B. Clay Face Brick: Facing brick complying with ASTM C 216.

1. Grade: SW.
2. Type: FBS.
3. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 5,000 psi.
4. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67.
5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
6. Nominal Size: As indicated on Drawings.
7. Color and Texture: Match Architect's samples.

2.6 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or II. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S, containing no air entrainment.

C. Masonry Cement is not acceptable.

D. Mortar Cement: is not acceptable.

E. Mortar Pigments: ASTM C 979/C 979M, Inorganic compounds used in the proportions recommended by the manufacturer, but no case exceeding 10% of the weight of the cement, carbon black shall not exceed 2% of the weight of the cement.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bayer Corporation, Industrial Chemicals Div.
   b. Davis Colors
   c. Solomon Grind-Chem Services, Inc.

2. Mortar Colors for Brick: Manufacturer’s standard colors as selected by the Architect. Each brick type shall have a difference standard color selected as follows:
   a. Brick Type A: Manufacturer’s standard color as selected by the Architect.

F. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
3. For joints less than 3/8 inch (9.5 mm) thick, use aggregate graded with 100 percent passing the No. 8 (1.18-mm) sieve and 95% passing the No. 16 (1.18-mm) sieve.
4. White-Mortar Aggregates: Natural white sand or crushed white stone.
5. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C 404.

H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ACM Chemistries.
b. BASF Corporation.
c. Euclid Chemical Company (The); an RPM company.
d. GCP Applied Technologies Inc.

I. Water: Potable.

*2.7* REINFORCEMENT.

A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420).

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

C. Masonry-Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Mill galvanized carbon steel.
2. Exterior Walls: Hot-dip galvanized carbon steel.
3. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
4. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
6. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

E. Masonry-Joint Reinforcement for Multiwythe Masonry:

1. Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of 1/16 inch (1.5 mm) and maximum vertical adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face.

2.8 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into veneer but with at least a 5/8-inch (16-mm) cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- (4.76-mm-), hot-dip galvanized steel wire.

D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire.

E. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf (445-N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.5 mm).
2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.105-inch- (2.66-mm-) thick steel sheet, galvanized after fabrication.
3. Fabricate wire ties from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized-steel wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Screw-Attached, Masonry-Veneer Anchors: Wire tie and a rib-stiffened, sheet metal anchor section with screw holes top and bottom, with a projecting vertical tab having a slotted hole for inserting wire tie.

    a. Manufacturers: Subject to compliance with requirements, provide products by the following:

        1) Hohmann & Barnard, Inc.
        2) Wire-Bond.

6. Screw-Attached, Masonry-Veneer Anchors: Wire tie and a rib-stiffened, sheet metal anchor section with screw holes top and bottom, with projecting tabs having holes for inserting vertical legs of wire tie formed to fit anchor section.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Heckmann Building Products, Inc.
2) Hohmann & Barnard, Inc.
3) Wire-Bond.

7. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours according to ASTM B 117.

## 2.9 EMBEDDED FLASHING MATERIALS

A. Flexible Flashing: Use the following unless otherwise indicated:

1. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637/D 4637M, 0.045 inch (1.14 mm) thick.

a. Basis-of-Design Product: Subject to compliance with requirements, provide Mortar Net Solutions; Total Flash unitized flashing and cavity drainage system or comparable product by one of the following:

1) Carlisle Coatings & Waterproofing Inc.
2) Firestone Specialty Products.
3) Heckmann Building Products, Inc.

b. Accessories: Provide preformed corners, end dams, and materials produced by flashing manufacturer.

1) Basis-of-Design Product: Mortar Net Solutions; CompleteFlash.

c. Sealants:

1) Basis-of-Design Product: Mortar Net Solutions; [**MPE-1, Modified Polyether**] [**BTL-1, Butyl**].

B. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use flexible flashing with a metal drip edge.
4. Where flashing is fully concealed, use flexible flashing.

C. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density Polyproplene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mortar Net Solutions; BlockFlash.

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

## 2.10 MISCELLANEOUS MASONRY ACCESSORIES

A. Expansion Joint Filler: ASTM D1065, Class RE41

1. Material: Closed cell neoprene
2. Compressibility: 50% minimum

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

D. Weep/Cavity Vent Products: Use[ **one of**] the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity. Use only for weeps.
2. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Heckmann Building Products, Inc.
2) Hohmann & Barnard, Inc.
3) Wire-Bond.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mortar Net Solutions; Mortar Net with Insect Barrier or comparable product by one of the following:

a. Advanced Building Products Inc.
b. Heckmann Building Products, Inc.
c. Wire-Bond.

2. Configuration: Provide one of the following:

a. Strips, full depth of cavity and 10 inches (250 mm) high, with dovetail-shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.
b. Strips, not less than 3/4 inch (19 mm) thick and 10 inches (250 mm) high, designed to catch mortar droppings and prevent weep holes from clogging with mortar.

## 2.11 MASONRY CLEANERS

A. General purpose, non-acidic, cleaner by ProSoCo, Diedrich, or as recommended by masonry unit manufacturer.

1. For Pre-faced CMU: Sure-Kleen Burnished Custom Masonry Cleaner or as recommended by the manufacturer.

## 2.12 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Structural Unit Masonry: Comply with ASTM C 270, Proportion Specifications for Type “S” for CMU; Portland lime mortar (1:1:6) except where indicated otherwise.

1. Provide only plant mixed mortar as specified. Mortar manufacturer shall provide test results indicating the mortar’s compliance with this specification.
2. Minimum compressive strength of mortar 1800 psi.

D. Mortar for Unit Masonry Veneer: Comply with ASTM C 270, Proportion Specifications for Type “N” for brick; Portland lime mortar (1:1:6) excerpt where indicated otherwise.
1. Provide only plant mixed mortar as specified. Mortar manufacturer shall provide test results indicated the mortar’s compliance with this specification.
2. Minimum compressive strength of mortar 750 psi for Type “N” mortar (birck).
3. Provide pigmented mortar for face-brick veneer as selected by Architect from manufacturer’s full color range, one color for each color and type of brick scheduled.

E. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.
3. Application: Use pigmented mortar for exposed mortar joints where indicated on Drawings.

F. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints where indicated on Drawings.

G. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp,

unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

## 3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

## 3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in **running bond**; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches (50 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

G. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

H. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 43 "Joint Firestopping."

## 3.5 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Rake out mortar joints at **pre-faced CMUs** to a uniform depth of 1/4 inch (6 mm) and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer 3/4 inch (19 mm) or more in width.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

E. Cut joints flush where indicated to receive [**waterproofing**] [**cavity wall insulation**] [**air barriers**] unless otherwise indicated.

## 3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods as follows:

1. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

a. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.

2. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Parge cavity face of backup wythe in a single coat approximately 3/8 inch (10 mm) thick. Trowel face of parge coat smooth.

D. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

## 3.7 ANCHORED MASONRY VENEERS

A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed tie sections in masonry joints.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 25 inches (635 mm) o.c. horizontally, with not less than one anchor for each 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

B. Provide not less than 1 inch (25 mm) of airspace between back of masonry veneer and face of insulation.

1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

## 3.8 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

1. Unless otherwise indicated on drawings or specified under specific wall type, space reinforcement not more than 16 inches (406 mm) o.c.
2. Unless otherwise indicated on drawings or specified under specific wall type, space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

## 3.9 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than 1 inch (25 mm) wide between back of masonry veneer and face of insulation.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

## 3.10 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Install preformed control-joint gaskets designed to fit standard sash block.

C. Form expansion joints in brick as follows:

1. Build in compressible joint fillers where indicated.
2. Form open joint full depth of brick wythe and of width indicated, but not less than 1/2 inch (13 mm) for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 1/4 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

## 3.11 LINTELS

A. Install steel lintels where indicated.

B. Provide [**concrete**] [**or**] [**masonry**] lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

## 3.12 FLASHING, WEEP HOLES, AND CAVITY VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal

penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches (200 mm), and 1-1/2 inches (38 mm) into the inner wythe.
3. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches (200 mm); with upper edge tucked under air barrier, lapping at least 4 inches (100 mm).
4. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 07 92 00 "Joint Sealants" for application indicated.
6. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 07 92 00 "Joint Sealants" for application indicated..
7. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall, and adhere flexible flashing to top of metal drip edge.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

E. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use specified weep/cavity vent products to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes 24 inches (600 mm) o.c. unless otherwise indicated.
4. Space weep holes formed from wicking material 16 inches (400 mm) o.c.
5. Trim wicking material flush with outside face of wall after mortar has set.

F. Place cavity drainage material in airspace behind veneers as follows:

1. At base of wall conditions and above loose-placed material at thru-wall lintel and shelf angle conditions: Strips, full depth of cavity and 8”-11” (203.2-279.5 mm) high, to prevent clogging with mortar droppings.
2. At veneer lintel and shelf-angle conditions for placement immediately between steel angle and cavity side of brick to maintain continuous drainage path to weeps: 0.4” – 0.5” (10.16 – 12.7 mm) thick material, loose fit. Place standard thickness material directly above lintel and 0.4” – 0.5” material for continuous, un-interrupted drainage of cavity.

G. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

## 3.13 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

## 3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
7. Clean stone trim to comply with stone supplier's written instructions.
8. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

## 3.15 FIELD QUALITY CONTROL

A. The CHA’s Designated Representative will perform inspections. Allow the CHA’s Designated Representative use of lift devices and scaffolding, as needed, to perform inspections.

B. The Architect's responsibilities at the site include observing progress and quality of portion of the Work completed. Allow Architect use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

C. Notify the CHA’s Designated Representative and the Architect in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until the CHA’s Designated Representative and Architect have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

## 3.16 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Excess Masonry Waste: Remove excess clean masonry waste and legally dispose of off CHA's property in accordance with Section 01 74 19 “Construction Waste Management and Disposal”.

**END OF SECTION**

**SECTION 05 12 00**

**STRUCTURAL STEEL FRAMING**

## PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Structural steel framing members.

B. Structural steel support members and struts.

C. Shear stud connectors.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.03 REFERENCE STANDARDS

A. AAMA TIR-A15 - Overview of Design Wind Load Determination for Fenestration Systems; 2014.

B. AISC (MAN) - Steel Construction Manual; 2017.

C. AISC 360 - Specification for Structural Steel Buildings; 2016.

D. AISC S303 - Code of Standard Practice for Steel Buildings and Bridges; 2016.

E. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2014.

F. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

G. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength; 2014a.

H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.

I. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished; 2013.

J. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

K. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2014 (Editorial 2017).

L. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2013.

M. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2015.

N. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts (Metric); 2007 (Reapproved 2013).

O. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling; 2017.

P. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2011 (Reapproved 2015).

Q. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions; 2015a.

R. ASTM F436/F436M - Standard Specification for Hardened Steel Washers Inch and Metric Dimensions; 2016.

S. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners; 2013.

T. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2015, with Editorial Revision (2017).

U. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2012.

V. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

W. SSPC-SP 3 - Power Tool Cleaning; 1982 (Ed. 2004).

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit copies of producer's or manufacturer's specifications and installation instructions for the following products. Include laboratory test reports and other data as required to show compliance with these specifications (including specified standards):
   1. Structural steel (each type), including certified copies of mill reports covering the chemical and physical properties, when requested.
   2. Structural steel primer paint.
   3. Shrinkage-resistant grout.

C. Shop Drawings:
   1. Submit Shop Drawings, including complete details and schedules for fabrication and assembly of members.
      a. The Fabricator shall either employ or retain a Structural Engineer licensed in the State of Illinois (Fabricator’s Engineer). All structural steel shop drawings shall be completed under the direct supervision and review of the Fabricator’s Engineer.

b. The Fabricator's Engineer shall seal, date and submit a letter simultaneously with the first submittal of structural steel shop drawings stating the following: "All structural steel shop drawings prepared for this project either have been or will be prepared under my direct supervision and review."
c. Structural steel shop drawings will not be reviewed by the Architect/Engineer of Record until the Fabricator's Engineer's letter is received.

2. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
3. Connections not detailed in the design drawings.
4. Indicate cambers and loads.
5. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.

D. Connection Calculations:
1. Submit calculations for framed beam connections and other connections not completely detailed in the design drawings. Calculations shall be stamped by the Fabricator's Engineer. Calculations shall be reviewed for general conformance with the design intent and shall be submitted for record only.
2. Calculations shall be submitted with the first shop drawing submittal, and shall be cross-referenced with all shop drawing submittals.
3. Shop drawings will not be reviewed without the submittal of coordinated connection calculations.

E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.
1. If recertification of welders is required, retesting shall be the Contractor's responsibility.

1.05 QUALITY ASSURANCE

A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual."

B. Codes and Standards: Comply with the provisions of the following, except as otherwise specified.
1. AISC "Load and Resistance Factor Design Specification for Structural Steel Buildings," latest edition, including Appendices and Supplements thereto.
2. AISC "Code of Standard Practice for Steel Buildings and Bridges", latest edition, with the following modifications:
a. In the Glossary, the term "Owner's Designated Representative for Design" shallbe defined as the Architect/Engineer of Record.
b. In Section 3.1.1, add the following to the end of the section: "Where reaction forces are given on the design drawings, Fabricator is responsible for designing stiffeners and/or doublers if necessary."
c. In Section 3.1.2, add the following to the end of the section: "Review of submitted connections by the Architect/Engineer of Record is limited to general conformance with the contract documents and the design intent. The Fabricator shall bear full responsibility for connection design."
d. Delete Section 3.3 in its entirety and substitute the following: "All situations which, in the opinion of the Contractor, appear to be deficiencies, omissions, contradictions, or ambiguities in the Design Drawings and Specifications, shallbe brought to the attention of the Architect/Engineer of Record. Design Drawings

and Specifications will be corrected or a written interpretation of the alleged deficiency, omission, contradiction, or ambiguity shall be made by the Architect/Engineer of Record before the affected work proceeds. When discrepancies exist between the Design Drawings and the Specifications, the Architect/Engineer of Record shall be informed in writing, and the Architect/Engineer of Record shall identify what shall govern. When discrepancies exist between scale dimensions in the Design Drawings and the figures written in them, the figures shall govern. When discrepancies exist between the structural design drawings and the architectural, electrical or mechanical design drawings or Design Drawings for other trades, the Architect/Engineer of Record shall advise what shall govern."

e. Delete Section 3.6 in its entirety and substitute the following: "Design drawings released as part of a bid package shall not be considered to be released for purchase of material or fabrication without 10 days prior notification to the Architect/Engineer of Record of intent to purchase or fabricate."

f. Delete section 4.4 in its entirety and substitute the following:

1) 4.4 - Except as provided in Section 4.5, the Shop and Erection Drawings shall be submitted to the Architect/Engineer of Record and the Board's Representative for review and approval. Approved Shop and Erection Drawings shall be individually annotated by the Architect/Engineer of Record and the Board's Representative as either approved or approved subject to corrections noted. When so required, the Fabricator shall subsequently make the corrections noted and furnish corrected Shop and Erection Drawings to the Architect/Engineer of Record and the Board's Representative for Construction. Submitted shop drawings shall allow for a review schedule as identified in Division 01."

2) 4.4.1 - Approval of the Shop and Erection Drawings is subject to corrections noted and similar approvals shall indicate the Fabricator has correctly interpreted the intent of the Contract Documents in the preparation of those submittals. Such approval shall not relieve the Fabricator of the responsibility for either the accuracy of the detailed dimensions in the shop and erection drawings or the general fit-up of parts that are to assembled in the field. Revise Section 10.2.3 to read "Weld show-through of members exposed to view is not acceptable without prior written approval from Architect/Engineer of Record."

3. AISC "Specification for Structural Joints Using ASTM A325 or ASTM A490" approved by the Research Council on Structural Connections of the Engineering Foundation.
4. AWS D1.1/D1.1M Structural Welding Code - Steel
5. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
6. AAMA TIR-A11 Maximum Allowable Deflection of Framing for Framing Systems for Building Cladding Components at Design Wind Loads.

C. Fabricator: Company specializing in performing the work of this section with minimum 5 years of documented experience.

1. Fabricator must participate in the AISC Quality Certification Program and be designated an AISC-Certified Plant as follows:
   a. Category: BU, certified building fabricator.

D. Erector: Company specializing in performing the work of this section with minimum 10 years of documented experience.

1. Erector must participate in the AISC Quality Certification Program and be designated an AISC-Certified Erector as follows:
   a. Category: CSE, certified steel erector; or CSEA, certified steel erector (advanced).

E. Design connections not detailed on the design drawings under direct supervision of a Licensed Structural Engineer experienced in design of this work and licensed in Illinois.

F. Design of Members and Connections: Unless otherwise indicated, provide standard AISC 360 framed beam connections using high strength bolts in shear/bearing type connections with threads included in the shear plane designed for the beam reactions indicated or if not indicated, provide a least three fourths of the uniform load carrying capacity of the beam.
   1. Provide a minimum of two (2) bolts at each connection.
   2. Provide connections at least one half the depth of the member.
   3. Provide slip-critical bolted connections in bolts installed in over-sized holes, in connections subject to fatigue, and in connections in which a combination of bolts and welds resist applied loads (weld only after bolts are tightened).

**PART 2 - PRODUCTS**

2.01 MATERIALS

A. Steel Angles, Plates, Channels, and Bars: ASTM A36/A36M.

B. Steel W Shapes and Tees: ASTM A992/A992M.

C. Rolled Steel Structural Shapes: ASTM A992/A992M.

D. Cold-Formed Structural Tubing: ASTM A500/A500M, Grade B.

E. Pipe: ASTM A53/A53M, Grade B, Finish black.

F. Stainless-Steel
   1. Stainless-Steel Bars and Shapes: ASTM A-276, Type 316L.
   2. Stainless-Steel Strip, Plate and Flat Bars: ASTM A-666, Type 316L.
   3. Stainless-Steel Pipe: ATM A-312/A-312M, Grade TP, 316L.
   4. Stainless-Steel Tubing: ASTM A-554, Grade MT, 316L.

G. Shear Stud Connectors: Made from ASTM A108 Grade 1015 bars.

H. Masonry Anchors:
   1. Where secured to flanges of member, weld on anchor rods consisting of 9" overall length, ¼" bright finished wire with 3/8" offsets to provide 4" adjustment of masonry anchors. Adjustable portion by Mason.
   2. Where secured to webs of members, weld on anchors consisting of 8 gauge hot dipped galvanized angle, 7" high x 1/2 flange depth with 1" return for fastening. Provide 5" high slotted hole 3/4" from outer edge to receive wire tie wire tie by Mason.

I. High-Strength Structural Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, with matching compatible ASTM A563 or ASTM A563M nuts and ASTM F436/F436M washers.

J. Unheaded Anchor Rods: ASTM F1554, Grade 36, plain, with matching ASTM A563 or ASTM A563M nuts and ASTM F436/F436M Type 1 washers.

K. Headed Anchor Rods: ASTM A307, Grade C, plain.

L. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:
   1. Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A325 unless design drawings indicate ASTM A490.

M. Load Indicator Washers: Provide washers complying with ASTM F959, Type 490 at connections requiring high-strength bolts, may be used at Contractor's option.

N. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

O. Grout: ASTM C1107/C1107M; Non-shrink; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
   1. Minimum Compressive Strength at 28 Days: 5,000 pounds per square inch.

P. Structural Steel Primer Paint (Except where specified otherwise): Lead and chromate free rust-inhibitive metal primer equal to Tnemec 10-99.

Q. Structural Steel Primer Paint for Architecturally Exposed Structural Steel: Organic Zinc-rich primer; Tnemec 90-97, Tneme-Zinc.

R. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

A. Shop fabricate to greatest extent possible.

B. Comply with AISC S303 and AISC 360

C. Shop Connections:
   1. Weld or bolt shop connections, as indicated.
   2. Bolt field connections, except where welded connections or other connections are indicated. Provide high-strength threaded fasteners. High-Strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts".
   3. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work. Assemble and weld built-up sections by methods, which will produce true alignment of axes without warp.

D. Shear Connectors: Prepare steel surfaces as recommended by the manufacturer of the shear connectors. Use automatic end welding of headed stud shear connectors in accordance with the manufacturer's printed instructions.

E. Space masonry anchors 16 inches on center.

F. Continuously seal joined members by continuous welds. Grind exposed welds smooth.

G. Fabricate connections for bolt, nut, and washer connectors.

H. Develop required camber for members.

2.03 FINISH

A. Prepare structural component surfaces in accordance with SSPC-SP 3.
   1. Provide SP-6 “Commercial blasting” where section is to receive zinc-blow primer.

B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, or high strength bolted.
   1. Provide 3 mils dry for organic zinc primer.

C. Galvanize structural steel members to comply with ASTM A123/A123M. Provide minimum 1.7 oz/sq ft galvanized coating.

D. Stainless-Steel:
   1. Conformed to European Standard EN 10088 for polished finish having maximum surface roughness of Ra20 micro-inches or 0.5 microns (minimum #6 finish).

**PART 3 - EXECUTION**

3.01 EXAMINATION

A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.02 ERECTION

A. Surveys: Check elevations of bearing surfaces, and locations of anchor rods and similar devices, before erection work proceeds, and report discrepancies. Do not proceed with erection until corrections have been made, or until compensating adjustments to the structural steel work have been agreed upon with the Architect/Engineer of Record.
   1. Employ a State of Illinois Licensed Surveyor.

B. Erect structural steel in compliance with AISC 303.

C. Allow for erection loads, and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.

D. Field weld components and shear studs indicated on shop drawings.
   1. Join steel components exposed in architecturally exposed steel by continuously welding. Chip, fill with metal body putty, and grind joints smooth to eliminate water pocketing and entering the assembly and provide smooth surface of welds. Provide all welded construction except where specifically shown otherwise on drawings. Remove backing bars and run-off tabs from members exposed to view.
   2. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of backside welding on exposed steel surfaces. Grind smooth fillet welds ½ inch (13mm) and larger. Grind flush butt welds. Dress exposed welds.

E. Do not field cut or alter structural members without approval of Architect/Engineer of Record.

F. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

G. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

3.03 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

3.04 FIELD QUALITY CONTROL

A. The Board will engage an independent testing and inspection agency to inspect structural steel materials, high-strength bolted connections, and welded connections and to perform tests and prepare test reports.

B. The Board's Testing Agency will conduct and interpret the tests and state in each report whether the test specimens comply with the requirements, and specifically state any deviations there from.

C. The Architect/Engineer of Record reserves the right to reject material not complying with specified requirements.

D. Correct deficiencies in structural steel work which inspections and laboratory test reports have indicated to be not in compliance with requirements. The Board may have additional tests performed, at Contractor's expense, as may be necessary to reconfirm any non-compliance of the original Work, and as may be necessary to show compliance of corrected Work.

E. Contractor's Responsibilities
   1. Notify Board's Testing Agency sufficiently in advance of operations to allow for his assignment of personnel and scheduling of tests.
   2. Coordinate with Agencies' personnel; provide access to Work and to plant operations.
   3. Furnish casual labor and facilities to provide access to Work to be tested to facilitate inspections and tests.

F. Shop and Field Testing Program By Board's Testing Agency: The following testing program outline is for information only and may not be comprehensive.
   1. Material and Welder Certification:
      a. Review each Contractor's mill reports covering chemical and physical properties of steel for conformance with the applicable ASTM specification.
      b. Review each Contractor's field welder certification for conformance with AWS certification requirements.
   2. Bolted Connections: Bolted connections shall be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".
      a. Visually inspect bolted connections.
      b. Perform calibrated wrench tests on all bolted, slip critical connections.

c. For connections not designated as slip critical, inspect connections to insure that the plies of the connected elements have been brought into snug contact.

3. Welded Connections: Welded connections shall be tested and inspected according to AWS D1.1/D1.1M.
   a. Perform visual inspection of all welded connections.
   b. Perform ultrasonic testing of all full penetration welds.
      1) Full penetration welds of HSS members shall meet AWS Class R Acceptance Criteria.
4. Shear Connectors: Welded shear connectors shall be tested and inspected according to AWS D1.1/D1.1M.
   a. Perform visual inspection of all welded shear connectors.
   b. Perform bend tests if visual inspection reveals a less-than-continuous 360-degree flash.

**END OF SECTION 05 12 00**

**SECTION 05 31 00**

**STEEL DECKING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roof deck.

B. Composite floor deck.

C. Stud shear connectors.

1.2 REFERENCE STANDARDS

A. AISC (MAN) - Steel Construction Manual; 2017.

B. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2012

C. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished; 2013.

D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.

E. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).

F. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2018.

G. SDI (DM) - Publication No.30, Design Manual for Composite Decks, Form Decks, and Roof Decks; 2007.

H. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); 2002 (Ed. 2004).

I. UL (FRD) - Fire Resistance Directory; current edition.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all relevant installers.

1. Ensure required submittals have been provided with sufficient time for review prior to scheduling the Preinstallation Meeting.

2. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work
   a. Require attendance by all affected installers including but not limited to
      1) Contractor's Superintendent
      2) Installer
      3) Manufacturer/Fabricator Representative
      4) Other affected Subcontractors
      5) Architect/Engineer of Record
      6) Board's Representative
3. Record minutes and distribute copies within 5 days after meeting to participants as well as Architect/Engineer of Record, Board and those affected by decisions made.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.

B. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.

C. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.

D. Calculations: Submit engineering calculations for the spans and loading conditions indicated for the deck proposed for use. Calculations to be stamped and signed by a Structural Engineer licensed in the state of Illinois and engaged by the fabricator.

E. Certificates: Certify that products furnished meet or exceed specified requirements..

1.5 QUALITY ASSURANCE

A. Design deck layout, spans, fastening, and joints under direct supervision of a Structural Engineer experienced in design of this work and licensed in Illinois. Structural Engineer to be engaged by the Fabricator.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Cut plastic wrap to encourage ventilation.

B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. Steel: Comply with AISC (MAN) Specifications.

B. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

C. Shop and Touch-Up Primer: Fabricator recommended, complying with VOC limitations of authorities having jurisdiction.

2.2 STEEL DECK

A. All Deck Types: Select and design metal deck in accordance with SDI Design Manual and AISI S100-12 .

1. Calculate to structural limit stress design and structural properties specified.
2. Maximum Vertical Deflection of Floor Deck: 1/240 of span.
3. Maximum Vertical Deflection of Roof Deck: 1/240 of span.
4. Install and anchor roof deck units to resist gross uplift loading of 30 pounds per square foot.
   a. At overhangs, anchor to resist 45 pounds per square foot.
   b.

B. Roof Deck: Non-composite type, fluted steel sheet:

1. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/230, with G90/Z275 galvanized coating.
2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
3. Structural Properties:
   a. Section Modulus: Minimum .318 in^3/ft.
   b. Span Design: Three Spans. Single and Double spans, if required, shall satisfy load and deflection requirements.
4. Minimum Base Metal Thickness: 18 gage, 0.0474 inch.
5. Nominal Height: 1-1/2 inch.
6. Profile: Fluted; SDI NR.
7. Formed Sheet Width: 24 inch.
8. Side Joints: Lock seam.
9. End Joints: Lapped, welded.
10. Fire Resistance Classification: Comply with UL (FRD) Assembly Number indicated on design drawings.

C. Composite Floor Deck: Fluted steel sheet embossed to interlock with concrete:

1. Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/230, with G90/Z275 galvanized coating.

2. Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.
3. Structural Properties:
   a. Section modulus: Minimum .504 in^3/ft.
   b. Span Design: Three Spans. Single and Double spans, if required, shall satisfy load and deflection requirements.
4. Minimum Base Metal Thickness: 18 gage, 0.0474 inch.
5. Nominal Height: 2 inches.
6. Profile: Fluted; SDI NR.
7. Formed Sheet Width: 24 inch.
8. Side Joints: Lock seam.
9. End Joints: Lapped, welded.

## 2.3 ACCESSORY MATERIAL

A. Stud Shear Connectors: Made from ASTM A108 Grade 1015 bars.

B. Welding Materials: AWS D1.1/D1.1M.

C. Fasteners: Galvanized hardened steel, self tapping.

D. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, complying with VOC limitations of authorities having jurisdiction.

E. Flute Closures: Closed cell, vulcanized, synthetic rubber, 1 inch thick; profiled to fit tight to the deck.

## 2.4 FABRICATED DECK ACCESSORIES

A. Sheet Metal Deck Accessories: Metal closure strips, wet concrete stops, and cover plates, 20 gage, 0.0359 inch thick sheet steel; minimum yield strength of 33,000 psi; of profile and size as indicated; finished same as deck.

B. Roof Sump Pans: Formed sheet steel, 14 gage, 0.0747 inch minimum thickness, flat bottom, sloped sides, recessed 1-1/2 inches below roof deck surface, bearing flange 3 inches wide, sealed watertight.

C. Floor Drain Pans: Formed sheet steel, 14 gage, 0.0747 inch minimum thickness, flat bottom, sloped sides, recessed 1-1/2 inches below floor deck surface, bearing flange 3 inches wide, sealed watertight.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions prior to beginning work.

3.2 INSTALLATION

A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.

B. On concrete and masonry surfaces provide minimum 4 inch bearing.

C. On steel supports provide minimum 1-1/2 inch bearing.

D. Fasten deck to steel support members at ends and intermediate supports at 12 inches on center maximum, parallel with the deck flute and at each transverse flute using methods specified.

1. Welding: Use fusion welds through weld washers.

E. Clinch lock seam side laps.

F. Weld deck in accordance with AWS D1.3/D1.3M.

G. At floor edges, install concrete stops upturned to top surface of slab, to contain wet concrete. Provide stops of sufficient strength to remain stationary without distortion.

H. Close openings above walls and partitions perpendicular to deck flutes with single row of foam cell closures.

I. Position roof drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.

J. Position floor drain pans with flange bearing on top surface of deck. Fusion weld at each deck flute.

K. Weld stud shear connectors through steel deck to structural members below.

L. Immediately after welding deck and other metal components in position, coat welds, burned areas, and damaged surface coating, with touch-up primer.

M. No permanent loading, other than the weight of supported concrete slabs shall be imposed on floor decking, until the concrete in such slabs has achieved 75 percent of its design strength

3.3 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction:

1. The Board's testing service will inspect deck, deck fastening, and side-lap fastening.
2. Correct deficiencies in the work that inspections and laboratory test reports have indicated to not be in compliance with requirements. The Board may have additional tests performed, at Contractor's expense, as may be necessary to reconfirm any non-compliance of the original Work, and as may be necessary to show compliance of corrected Work.

B. Contractor’s Responsibilities

1. Notify Agency sufficiently in advance of operations to allow for his assignment of personnel and scheduling of tests.
2. Coordinate with Agencies’ personnel, provide access to Work.
3. Furnish casual labor and facilities to provide access to Work to be tested to facilitate inspections and tests.

3.4 CLEANING

A. Shop Finish Touchup and Repair: Clean and touch-up field welds, bolted connections and abraded areas.

B. Restore finishes damaged during installation and construction period.

3.5 PROTECTION

A. Protect installed products from damage during construction.

**END OF SECTION**

**SECTION 05 40 00**

**COLD-FORMED METAL FRAMING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Soffit framing.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for masonry shelf angles and connections.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.
3. Section 092216 "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

### 1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site**.** Prior to start of installation of metal framing systems, meet at Project site with installers of other work, including door and window frames, mechanical and electrical work. Review areas of potential interference and conflicts and coordinate layout and support provisions for interfacing work.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

B. Shop Drawings:

1. Include layout, spacing, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated-Design Submittal: For cold-formed steel framing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Research Reports: For non-standard cold-formed steel framing introduced into project or as indicated, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency**,** or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness..

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. All Steel & Gypsum Products, Inc.
2. California Expanded Metal Products Company.
3. Clark Western Building Systems, Inc.
4. Consolidated Fabricators Corp.; Building Products Division.
5. Craco Mfg., Inc.
6. Custom Stud Inc.
7. Design Shapes in Steel.
8. Dietrich Metal Framing; a Worthington Industries Company.
9. Formetal Co. Inc. (The).
10. Marino WARE.

11. Nuconsteel; a Nucor Company.
12. Olmar Supply, Inc.
13. Quail Run Building Materials, Inc.
14. SCAFCO Corporation.
15. Southeastern Stud & Components, Inc.
16. State Building Products, Inc.
17. Steel Construction Systems.
18. Steel Network, Inc. (The).
19. Steel Structural Systems.
20. Steeler, Inc.
21. Super Stud Building Products, Inc.
22. Telling Industries, LLC.
23. United Metal Products, Inc.
24. United Steel Manufacturing.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated and required by code
2. Deflection Limits: Design exterior wall systems to sustain 30psf acting inward and outward (except 40 psf at corners) with a maximum deflection of L/600. Spacing as noted on drawings.
3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

    a. Upward and downward movement of 1-1/2 inches.

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Design Standards:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre consumer recycled content not less than 25 percent.

B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural design.
2. Coating: G60

C. Steel Sheet for Vertical Deflection and Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.
2. Coating: G60

D. Vertical Deflection Clips: Manufacturer's standard bypass and head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

Retain "Manufacturers" Subparagraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. All Steel & Gypsum Products, Inc.
b. Clark Western Building Systems, Inc.
c. Dietrich Metal Framing; a Worthington Industries company.
d. Marino WARE.
e. SCAFCO Corporation.
f. Steel Network, Inc. (The).
g. Steeler, Inc.

E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

## 2.4 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, G60 metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

## 2.5 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

## 2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, no staining grout containing selected silica sands, Portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.

D. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

## 2.7 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

### 3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

## 3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated.

C. Set studs plumb, except as needed for diagonal bracing or required for no plumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to bypassing and infill studs. Anchor to building structure.

4. Connect drift clips to cold-formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches max apart. Fasten at each stud intersection.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

## 3.5 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

## 3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

**METAL FABRICATIONS**
**SECTION 05 50 00**

## PART 1 GENERAL

1.01 SECTION INCLUDES:

A. Work under this Section is subject to the requirements of the Contract Documents.

B. Furnish and install all Metal Fabrications Work as shown on the Drawings and as specified herein, including but not limited to the following:

1. Lintels/ Shelf Angles

2. All other metal fabrication work not included as work specified under Section 05 12 00 -- "Structural Steel", or specifically specified above, but as required for a complete installation of miscellaneous work.

3. Shop Prime Painting.

4. Field Touch-Up Painting.

5. Gratings and frames.

C. Install all items as shown on the Drawings and as specified to be furnished under other Sections.

1.02 RELATED WORK:

A. As specified in the following divisions:

1. Division 3 - Concrete

2. Division 9 - Finishes

3. Division 10 - Specialties

1.03 REFERENCES:

A. AAMA 603.8 - Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.

B. AAMA 605.2 - Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.

C. AAMA 606.1 - Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.

D. AAMA 607.1 - Specifications and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.

E. AAMA 608.1 - Specification and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum.

F. ANSI A14.3 - Ladders, Fixed, Safety Requirements.

G. ANSI A 202.1 - Metal Bar Grating Manual for Steel and Aluminum Gratings.

H. ASTM A 36 - Structural Steel.

I. ASTM A 53 - Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.

J. ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

K. ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

L. ASTM A 283 - Carbon Steel Plates, Shapes, and Bars.

M. ASTM A 307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

N. ASTM A 446 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip process, Physical (Structural) Quality.

O. ASTM A 500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.

P. ASTM A 501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

Q. ASTM B 26 - Aluminum-Alloy Sand Castings.

R. ASTM B 85 - Aluminum-Alloy Die Castings.

S. ASTM B 177 - Chromium Electroplating on Steel for Engineering Use.

T. ASTM B 209 - Aluminum and Aluminum-Alloy Sheet and Plate.

U. ASTM B 210 - Aluminum-Alloy Drawn Seamless Tubes.

V. ASTM B 211 - Aluminum-Alloy Bar, Rod, and Wire.

W. ASTM B 221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.

X. ASTM E 935 - Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.

Y. AWS A2.0 - Standard Welding Symbols.

Z. AWS D1.1 - Structural Welding Code.

AA. NAAMM - Metal Bar Grating Manual.

BB. SSPC (The Society for Protective Coatings) - Steel Structures Painting Manual.

CC. AISC – Manual of Steel Construction

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. Fabrications must comply with applicable codes and regulations and safely support the following minimum design loads without deformation:

1. Gratings: minimum 60 psf uniform live load and a 300 lb. concentrated live load in center of unit, except when greater live load requirements are indicated.

2. Railings:

a. Concentrated load of 200 lbf applied at any point and in any direction.

b. Uniform load of 50 lbf per linear foot applied horizontally and concurrently with uniform load of 100 lbf per linear foot applied vertically downward.

c. Concentrated and uniform loads above need not be assumed to act concurrently.

1.05 SUBMITTALS:

A. Submit the following:

1. Shop Drawings

a. Provide shop drawings signed and sealed by a state of Illinois licensed structural engineer with a statement of compliance with “Design and performance requirements” of this specification.

b. Shop details for the fabrication and assembly of all miscellaneous metal work, including information covering materials, sizes and shape of members; details of joints connections, pipe sleeves, and bracket connections.

c. All welding must be indicated using AWS symbols and showing length, size and spacing (if not continuous). Auxiliary views must be shown to clarify all welding.

d. Such welds as “¼" weld" and "tack weld" will not be acceptable.

e. Erection diagrams, connection details and design calculations sealed by a licensed Structural Engineer in the State of Illinois must be submitted with the Shop Drawings.

2. Product Data

3. Test Reports

a. Submit test reports necessary to show compliance with the Contract Documents.

4. Manufacturer’s Certification

a. Submit certification that products meet or exceed the specified requirements.

(1) Certification of welders.

(a) Certification that each operator has passed the qualification tests as required in Paragraph 2.04.

(2) Welding must be executed by operators who have been qualified previously as prescribed in the American Welding Society's "Standard Qualification Procedure" for the required type of work.

b. Welders must be certified by an approved testing laboratory in accordance with Paragraph 2.04, and a copy of certification that each operator has passed the tests must be furnished.

1.06 QUALITY CONTROL:

A. Contractor Qualifications: Fabrication and Installation of metal fabrication must be performed only by a qualified fabricator. The term qualified means experienced in performing the Work required by this Section. The Contractor must have a documented experience on Projects similar in size and scope to this Project. The Contractor must submit evidence of such qualifications upon request.

B. Perform Work in accordance with the latest edition, of the appropriate divisions, of the following:

1. Structural steel details, fabrication, and erection must conform to AISC “Manual of Steel Construction” unless otherwise shown or specified.

2. All structural steel material must be ASTM A 36 and all structural steel tubes must be ASTM A 500, Grade B, unless noted otherwise.

3. Field connections must be bolted. High strength bolts must be installed in accordance with AISC Specifications. Bolts must be ASTM A 325, ¾" diameter unless noted otherwise. All welding to be done by certified welders (See Specifications). All welds to be E70 XX Electrodes.

4. Shop and field welding procedures and standards of acceptance must be in accordance with AWS D1.1 “Structural Welding Code”, American Welding Society, latest edition.

5. Standard welded connections for simple framing must be as shown in Table III and Table V of the “Manual of Steel Construction”, latest edition.

6. Where welding occurs, it must be by the electric arc process in accordance with referenced standards.

7. An independent testing laboratory must be retained by the Contractor and must attest to welder qualification tests. The Contractor must notify the testing laboratory of all welding operations and leave staging in place until tests and inspections have been completed.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Materials must be delivered to the Project bearing Manufacturer's name and material identification. Materials must be stored in strict accordance with the Manufacturer's printed directions, copies of which must be furnished to the Owner.

B. Exercise care in storing, handling and erecting structural steel and provide necessary blocking or other supports required and in supporting it properly at all times to insure that no piece will be bent, twisted, or otherwise damaged. Damaged material must be corrected to the approval of the Owner before being erected, or replace when so directed by the Owner.

C. Protect materials against damage from mechanical abuse, plaster, salts, acids, staining and other foreign matter by an approved means during transportation, storage and erection and until completion of construction work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new materials.

D. Storage of fabricated metal at the job site must be the responsibility of the Contractor. Materials stored at the job site must be so placed that no members will be damaged and must be protected against corrosion or deterioration of any kind. The Owner reserves the right to reject any material that has become damaged because of improper storage.

E. Before proceeding with fabrication of the metal fabrications work, the installer must verify all dimensions and take such measurements as are required for proper fabrication and erection of the work.

F. Access and Storage Areas

1. All access routes and storage areas must be subject to the approval of the Owner in order to reduce interference with Airport Operations.

1.08 SPECIAL REQUIREMENTS:

A. Field Measurements - Before proceeding with the fabrication of the work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the work.

B. Coordination - Coordinate Work of this Section with related Work specified in the other divisions/sections of the Contract Documents.

**PART 2 PRODUCTS**

2.01 MATERIALS:

A. Structural Steel Shapes and Plates must comply with ASTM A 36 or ASTM A283.

B. Steel Plates to be Bent or Formed Cold must comply with ASTM A 203 or ASTM A 283.

C. Steel Tubing (Hot-formed, welded or seamless) must be comply with ASTM A 501.

D. Hot-rolled, rail carbon steel bars and shapes must comply with ASTM A 74.

E. Cold-finished Steel Bars must comply with ASTM A 108.

F. Hot-Rolled Carbon Steel Sheets and Strips must comply with ASTM A 570.

G. Cold-Rolled Carbon Steel Sheets must comply with ASTM A 366.

H. Galvanized Carbon Steel Sheets must be ASTM A 446, Grade A, and with, ASTM A525 G90 zinc coating.

I. Steel Pipe must be welded or seamless, ASTM A 120, black and hot dipped galvanized, unless noted otherwise; or ASTM A 53, type and grade as selected by the fabricator and as required for design loading, standard weight, black unless galvanizing is specified.

J. Bolts and Nuts must comply with ASTM A 307, Grade A, galvanized.

K. Welding Electrodes must comply with AWS Specifications.

L. High Strength Bolts, Nuts and Washers must comply with ASTM A-325 or ASTM A 490.

M. Metal Primer for surfaces which will receive an epoxy, a polyurethane, or other finish coat: as recommended by the finish coat manufacturer.

N. Metal Primer for surfaces which will not receive a finish coat: rust inhibitive metal primer standard with the fabricator.

O. Zinc Rich Compound/ (touch-up primer for architecturally exposed structural steel)/: high-zinc-dust-content paint with dry film containing not less than 94 percent dust by weight, and complying with SSPC Paint 20, “Z.R.C. Cold Galvanizing Compound” (e.g. ZRC Products Co.) at 1.5 mils dry film thickness.

P. Bituminous Paint: cold applied asphalt mastic paint complying with SSPC Paint 12, formulated for 30 mil thickness per coat.

Q. Galvanizing steel or iron specified or noted as "galvanized" must be coated by the hot-dipped process conforming to ASTM A 120, with a continuous uniformly thick coating of molten zinc, unless noted otherwise. Average weight of coatings must be not less than 2 ounces per square foot of surface.

1. Items must be galvanized after fabrication. Where size of assembled item is too large for galvanizing, only those assemblies may be galvanized prior to fabrication.

R. Hydraulic Cement/Grout: Pproducts of one of the following Manufacturers will be acceptable:

1. "Prorok" - Hallemite Company;

2. "Rockitite" - Hartline Products Co; Inc.;

3. "Five Star Instant Grout" - U.S. Grout Corporation; or

4. "Dam-It" - Euclid Chemical Co.

5. “Por-Rok” – Minwax Construction Products Div.

6. “Intraplastic” – Sika Corporation

7. “Embeco Mortar” – Master Builders, Inc.

1. Steel Pipe

a. Must comply with ASTM A 53; type as selected; Grade A; black finish unless galvanizing is required; standard weight (Schedule 40), unless otherwise indicated.

2. Brackets, Flanges, and Anchors

a. Cast or formed metal of the same type of material and finish as supported rails, unless otherwise indicated.

3. Steel Finish

a. Shop prime paint a minimum of two (2) mils, except where galvanized finish is indicated.

4. Non-shrink Non-ferrous Grout

a. CE CRD C 588.

2.02 SHOP WELDERS QUALIFICATION:

A. Welders for shop fabrication, including tack welders, must be certified and tested by an AWS Certified Welding Inspector (CWI) and the certifications signed by the same, within six (6) months before start of Work. Submit welder certifications to the Owner. Those currently certified, and who are performing under the classification necessary for their work for this Contract, need not be re-certified. A forementioned certification by the Contractor will be acceptable if submitted prior to welding for the Project.

B. In the event that the Owner or the testing laboratory retained by the Owner, requests, in writing, re-certification of a welder doing work for this Contract, the welder will be required to do so for this work.

1. The tests and re-certification must be paid for by the Contractor.

2.03 GENERAL WELDING REQUIREMENTS:

A. Standard welded connections for simple framing must be as shown in Table III and Table V of the "Manual of Steel Construction", latest edition.

B. Where welding occurs, it must be by the electric arc process in accordance with referenced standards.

C. Welded connection of equal value may be substituted for bolted connection as shown on the Drawings, subject to approval of the Owner.

D. Shop and field welding procedures and standards of acceptance must be in accordance with AWS Dl.1 "Structural Welding Code", American Welding Society, latest edition.

2.04 FABRICATION OF MISCELLANEOUS STEEL:

A. Work under this Section must be executed only by concerns of standing, approved by the Owner.

1. All exposed work must be made perfect in materials, workmanship and finish.

2. Field work must be done by skilled mechanics.

3. Angles and lines must be straight and true; surfaces must be smooth and free from all waves and buckles.

4. Do all cutting and drilling necessary for fitting work in place and erect all work in place in firm, rigid and workmanlike manner.

B. Work under this Section must be executed by a fabricator of established reputation who is regularly engaged in the fabrication of miscellaneous and ornamental iron work. Contractor must submit for Owner's approval name of fabricator that will perform the work.

C. Shop assembled members must be welded. No field riveting will be permitted; field connections must be high strength bolted or welded. All welds must be ground smooth and flush with adjacent surfaces.

D. Where welding occurs, it must be by the electric are process in accordance with American Welding Society's Code for Arc and Gas welding in Building Construction.

E. Provide all lugs, connections, anchors, rods, etc., necessary for complete erection.

F. No burning of steel will be permitted in the field. Members burned in the shop must be finished to an acceptable appearance, equal to a sheared finish. Holes must not be burned in either shop or field. No cutting of structural shapes must be done in the field without the consent of the Owner.

G. Materials must be properly marked and match-marked where field assembly is required. The sequence of shipments must be such as to expedite erection and minimize the field handling of materials.

H. Use care in handling and erection to insure that steel must not be twisted, bent or otherwise damaged, and should any difficulty be encountered, it must be immediately reported to the Owner.

I. Connections at angles, miters and junctions which cannot be forged or welded must be made with blind screws from the back or other concealed fastenings.

1. Furnish and install all additional clips, angles, braces, framing and supports required for anchoring this work to the masonry or structural frame of building or for supporting other work as shown.

2. Provide proper expansion joints in continuous metal work where required as approved by the Owner.

3. Exposed work must be finished smooth and even, with close joints and connections. Exterior joints and connections must be formed to exclude water.

1. Surfaces that will be inaccessible for painting after assembly or installation must be given two (2) shop coats of primer.

J. Shop coat will not be required on hot dip galvanized or zinc-coated metal unless otherwise specified but abraded places and welds must be touched up with aluminum paint. Do not prime surfaces encased in concrete or contact surfaces to be welded or high-strength bolted.

K. Exterior steel must be hot-dip galvanized a minimum of 1.25 oz. per sq. ft. and conform to ASTM A 153 for hardware and ASTM A 123 for both fabricated assemblies and

unfabricated products made of rolled, pressed and forged shapes, plates, bars and strips.

L. Electrogalvanizing must conform to ASTM B 633 and the requirements for the appropriate service conditions listed therein.

2.05 SHOP FINISHES OF MISCELLANEOUS STEEL:

A. All metal fabrications work must be thoroughly cleaned and steel items must be given one heavy shop coat of an approved zinc chromate primer, well worked into all concrete or contact surfaces to be welded or high-strength bolted. After erection, touch-up as required. Surfaces which are not accessible for field painting must have two coats of this paint before leaving the shop.

B. Surfaces within 2" of any field weld location must be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done. If shop painted, surfaces to be welded must be wire brushed in the field before welding to reduce paint film to a minimum. After welding, all weld areas and abrasions must be touched up after cleaning.

PART 3 EXECUTION

3.01 INSPECTION:

A. Before commencing installation, examine substrate surfaces to determine that they are free of conditions which might be detrimental to proper and timely completion of the work. Start of work must indicate acceptance of the substrate.

3.02 FIELD WELDERS QUALIFICATIONS:

A. Field welders must be qualified according to applicable Specification for Manual shielded-arc welders and according to AWS SR-1 for gas metal-arc welders. Field welders must be certified and tested by an AWS Certified Welding Inspector (CWI) and the certifications signed by the same, within 6 months before start of Work. Qualification tests and certifications must be paid for by the Contractor.

1. Those currently certified for the classifications necessary for their work will not be required to be re-certified. The aforementioned certification will be acceptable if submitted to the Owner prior to the start of any field welding.

B. In the event the Owner or the Testing Laboratory retained by the Owner requests in writing for the re-qualification of welder at any time during the erection welding activities of the Project, said welder must be re-qualified.

1. The Contractor must pay the costs for the retesting and re-qualification certification.

2. Gas metal-arc welders (including internship) need only be qualified for those weld positions for which they will be actually engaged.

3. Manual shielded arc welders must be qualified for at least unlimited horizontal groove and vertical fillet welds.

3.03 LOOSE LINTELS/ SHELF ANGLES:

A. Loose lintels/ shelf angles over openings in masonry walls must be of size, dimensions and type shown on Drawings. Lintels must bear not less than 8" on each side of openings, and installed as work required under Section 04220 -- "Concrete Masonry Units".

3.04 PIPE HANDRAIL:

A. Pipe handrails must be fabricated of extra strong galvanized steel pipe, conforming to design requirements shown on Drawings. All rails and posts must be free from nicks, dents or abrasions, and straight and true for their entire length.

B. Join all parts with hairline contact, flush and smooth with adjacent surfaces using concealed welds and fasteners where possible.

1. Grind exposed welded areas smooth to match and blend with finished surfaces.

3.05 INSPECTION:

A. Before commencing installation, examine substrate surfaces to determine that they are free of conditions which might be detrimental to proper and timely completion of the work. Start of work must indicate acceptance of the substrate.

3.06 INSTALLATION:

3.07 GENERAL CLEANING:

A. All rubbish and debris resulting from the Work of this Section must be collected, removed from the site and disposed of legally.

B. All work areas must be left in a broom clean condition.

**END OF SECTION 05500**

**SECTION 05 52 17**

**ROOFTOP FALL PROTECTION**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Roof accessories including the following:
   1. Mobile safety railing system for MAU platform edge fall protection (SRC360).
   2. Permanent flush-mount single and double railing brackets.
   3. Fixed ladders.
   4. Roof hatch guarding.

1.3 RELATED SECTIONS

A. Section 05 50 00 - Metal Fabrications

B. Section 11 81 29 – Facility Fall Protection

1.4 REFERENCES

A. American National Standards Institute (ANSI): ANSI A14.3 - American National Standards for Ladders - Fixed - Safety Requirements.

B. American Welding Society: AWS D1.1 - Structural Welding Code - Steel.

C. American Welding Society: AWS D1.3 - Structural Welding Code - Sheet Steel.

D. Occupational Safety and Health Administration (OSHA): 29 CFR 1910.28 Duty to Have Fall Protection and Falling Object Protection.

E. Occupational Safety and Health Administration (OSHA): 29 CFR 1910.29. Walking-Working Surfaces.

F. Occupational Safety and Health Administration (OSHA): 29 CFR 1910.23 - Fixed Ladders.

G. Occupational Safety and Health Administration (OSHA): 29 CFR 1926.500 - Scope, Application, and Definitions Applicable to this Subpart.

H. Occupational Safety and Health Administration (OSHA): 29 CFR 1926.501 - Duty to Have Fall Protection.

I. Occupational Safety and Health Administration (OSHA): 29 CFR 1926.502 - Fall Protection Systems Criteria and Practices.

J. Occupational Safety and Health Administration (OSHA): 29 CFR 1926.503 - Training Requirements.

## 1.5 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Shop Drawings: Drawings showing plans, elevations, sections and details of components. Show member sizes and part identification, fasteners, anchors, fittings and evidence of compliance with structural performance requirements.

D. Manufacturer's Certificates:
1. Certify that Railings and Base Castings are made in USA. Provide steel mill and foundry certificates for verification prior to shipment.
2. Manufacturer must be American Welding Society Welding Certified for Welding Standards AWS D1.1 and AWS D1.3. Third party qualification documentation required prior to shipment.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in good condition and adequately protected against damage as handrails are a finished product.

B. Inspect rail sections for damage before signing the receipt from the trucking company. Truck driver must note damaged goods on the bill of lading if damaged product is found.

C. Store products in manufacturer's unopened packaging until ready for installation.

D. Products to be palletized and labeled by roof level or designated drop zone.

## 1.7 PROJECT CONDITIONS

A. Field Measurements: Where handrails and railings are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication.

1.8 WARRANTY

A. Warranty: Provide manufacturer's limited two year warranty.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Safety Rail Company, which is located at: 4244 Shoreline Dr.; Spring Park, MN 55384; Toll Free Tel: 888-434-2720; Fax: 888-471-4931; Email: jim.sidla@safetyrailcompany.com. Web: www.safetyrailcompany.com

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 ROOF HATCH GUARDING:

A. Provide Safety Rail Company roof hatch guarding including railings, bases, accessories and fittings.
   1. Product: SRC Roof HatchGuard, Non-Penetrating Fall Protection.
      a. Roof Hatch Size: As Specified by Architect.
   2. OSHA-compliant fall protection per 29 CFR 1910.29, 29 CFR 1926.501(b) (4) and 29 CFR 1926.502.
   3. One-piece, welded design. No assembly required.
   4. No drilling into hatch or roof. Elastomeric tipped compression bolts are tightened against the curb of the roof hatch.
   5. Self-closing gate included.
   6. 24 in (610 mm) safe landing zone. Personnel can safely step out of the hatch and gain their footing, prior to engaging the gate.
   7. Built-in grab bars.
   8. Finish: Steel surfaces.
      a. Hot Dip Zinc Galvanized and factory finished powder coat paint.
      b. Color: Specified by Architect.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions, approved submittals and in proper relationship with adjacent construction.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion

**END OF SECTION**

**SECTION 06 10 00**

**ROUGH CARPENTRY**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Framing with engineered wood products.
3. Rooftop equipment bases and support curbs.
4. Wood blocking, cants, and nailers.
5. Wood blocking at gravel stops

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

D. OSB: Oriented strand board.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component material and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include

physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

b. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Engineered wood products.
3. Shear panels.
4. Power-driven fasteners.
5. Post-installed anchors.
6. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. Certified Wood: Provide wood and wood products produced from wood obtained frfom forests certified by an FSC-accredited certification body to comply with FSC 1.2, “Principles and Criteria.”

1. Dimension lumber framing.
2. Timber.
3. Laminated-veneer lumber.
4. Parallel-strand lumber.
5. Prefabricated wood I-Joists.
6. Rim boards.
7. Miscellaneous lumber.

C. Low-Emitting Materials – Adhesives: Use interior adhesives that comply with VOXC limits of South Coast Air Quality Management District Rule 1168 effective date of July 1, 2005 and rule amendment date of January 7, 2005. VOC limits include but are not limited to the following:

1. Multipurpose Construction Adhesives: 70 g/L.

D. Low-Emitting Materials – Composite Wood and Agrifiber Products: Use composite wood and agrifiber products that contain no added urea-formaldehyde resins on the interior of the building. Laminating adhesives used to fabricate such products shall also not contain added urea-formaldehyde resins.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

**PART 2 - PRODUCTS**

2.1 WOOD PRODUCTS, GENERAL

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
3. Where nominal sized are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sized for dry lumber.
4. Dress lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness unless otherwise indicated.

D. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.

1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions: Construction or No. 2 grade.

1. Application: Interior partitions not indicated as load bearing.
2. Species:
   a. Southern pine or mixed southern pine; SPIB.
   b. Northern species; NLGA
   c. Eastern softwoods; NeLMA.
   d. Western woods; WCLIB or WWPA

B. Framing Other Than Non-Load-Bearing Partitions: Construction or No. 2 grade.

1. Application: Framing other than interior partitions not indicated as load bearing.
2. Species:
   a. Hem-fir (north); NLGA.
   b. Southern pine; SPIB.
   c. Douglas fir-larch; WCLIB or WWPA.
   d. Southern pine or mixed southern pine; SPIB.

e. Spruce-pine-fir; NLGA.
f. Douglas fir-south; WWPA.
g. Hem-fir; WCLIB or WWPA.
h. Douglas fir-larch (north); NLGA.
i. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

C. Exposed Framing: Hand-select material for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.

1. Species and Grade: As indicated above for load-bearing construction of same type

A. MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

1. Northern species; No. 2 Common grade; NLGA.
2. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

B. FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

E. Wood Screws: ASME B18.6.1.

F. Lag Bolts: ASME B18.2.1.

G. Bolts: Steel bolts complying with SASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete

as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

C. METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cleveland Steel Specialty Co.
2. KC Metals Products, Inc.
3. Phoenix Metal Products, Inc.
4. Simpson Strong-Tie Co, Inc.
5. USP Structural Connectors.

B. Allowable design loads, as published by manufacturer, shall meet or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.

1. Use for interior locations unless otherwise indicated.

D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.

1. Use for wood-preservative-treated lumber and where indicated.

E. Stainless-Steel Sheet: ASTM A 666, Type 304.

1. Use for exterior locations and where indicated

F. Joist Hangers: U-shaped joist hangers with 2-inch –long seat and 1-1/4-inch- wide nailing flanges at least 85 percent of joist depth.

1. Thickness: 0.062 inch.

G. Top Flange Hangers: U-shaped joist hangers, full depth of joint, formed from metal strap with tabs bent to extend over and be fastened to supporting member.

1. Strap Width: 2 inches.
2. Thickness: 0.062 inch.

H. Post Bases

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

C. Provide blocking and framing as indicated and as required to support facing materials and trim.

### 3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

**END OF SECTION**

**SECTION 06 20 23**

**INTERIOR FINISH CARPENTRY**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Interior trim.
2. Shelving and clothes rods.

B. Related Requirements:

1. Section 061000 "Rough Carpentry."
2. Section 099123 "Interior Painting" for priming and backpriming of interior finish carpentry.

### 1.3 DEFINITIONS

A. MDF: Medium-density fiberboard.

B. MDO: Plywood with a medium-density overlay on the face.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

B. Samples: For each type of paneling.

### 1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranty.

1.6 FIELD CONDITONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration..

**PART 2 - PRODUCTS**

2.1 MATERIALS, GENERAL

A. Lumber: DOC PS 20.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by grading agency.

B. Softwood Plywood: DOC PS 1.

C. Hardboard: AHA A135.4.

D. MDF: ANSI A208.2, made with binder containing no urea-formaldehyde resin.

E. Particleboard: ANSI A208.1, made with binder containing no urea-formaldehyde resin.

F. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.

1. Color: As selected by Architect from manufacturer's full range.

G. Certified Wood: For wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship".

H. All composite wood products (plywood, OSB, MDF, cabinetry, etc.) must be certified as compliant with California 93120 Phase 2. Or, if using a composite wood product that does not comply with California 93120 Phase 2, all exposed edges and sides must be sealed with low-VOC sealants, per Criterion 6.2.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed lumber and plywood indicated to receive a stained or natural finish, mark back of each piece.

C. Application: Where indicated.

2.3 INTERIOR TRIM

A. Softwood Lumber Trim:
1. Species and Grade: Douglas fir-larch or Douglas fir south, Superior or C & Btr finish; NLGA, WCLIB, or WWPA.
2. Maximum Moisture Content: 15 percent.
3. Finger Jointing: Not allowed.

B. Hardwood Lumber Trim:

1. Species and Grade: Match species of existing historic trim., Clear; NHLA.
2. Maximum Moisture Content: 10 percent.
3. Finger Jointing: Not allowed.

C. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): MMPA HWM 4, N-grade wood moldings made to patterns included in MMPA's "HWM/Series Hardwood Moulding Patterns."

1. Species: Match species of existing historic trim.
2. Maximum Moisture Content: 9 percent.
3. Finger Jointing: Not allowed.

D. Moldings for Opaque Finish (Painted Finish): Made to patterns included in MMPA's "WM/Series Wood Moulding Patterns."

1. Hardwood Moldings: MMPA HWM 4, P-grade.

a. Species: Aspen, basswood, cottonwood, gum, magnolia, soft maple, tupelo, or yellow poplar.
b. Maximum Moisture Content: 9 percent.

2. Optional Material: Primed MDF.

3. Finger Jointing: Not allowed.

E. Molding Patterns:

1. Base Pattern: 11/16” square profile base to match height of adjacent existing historic baseboard.
2. Shoe-Mold Pattern: 3/8”-square profile shoe mold to match height of adjacent existing historic base shoe.

2.4 SHELVING AND CLOTHES RODS

A. Closet and Utility Shelving: Made from one of the following materials, 3/4 inch thick.

1. MDF with solid-wood front edge.
2. MDO softwood plywood with solid-wood edge.
3. Melamine-faced particleboard with radiused and filled front edge.
4. Softwood Boards: Kiln-dried Douglas fir-larch, Douglas fir south, or hem-fir, Superior or C & Btr finish; NLGA, WCLIB, or WWPA; or southern pine, B & B finish; SPIB.

B. Shelf Cleats: 3/4-by-5-1/2-inch boards with hole and notch to receive clothes rods, as specified above for shelving.

C. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.

D. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.

E. Clothes Rods: 1-1/2-inch- diameter, clear, kiln-dried hardwood.

2.5 MISCELLANEOUS MATERIALS

A. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.2 INSTALLATION, GENERAL

A. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
4. Install stairs with no more than 3/16-inch variation between adjacent treads and risers and with no more than 3/8-inch variation between largest and smallest treads and risers within each flight.

## 3.3 STANDING AND RUNNING TRIM INSTALLATION

A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches long, except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints.

## 3.4 PANELING INSTALLATION

A. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.

1. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners and adhesive as recommended by panel manufacturer.
2. Conceal fasteners to greatest practical extent.

B. Hardboard Paneling: Install according to manufacturer's written recommendations. Leave 1/4-inch (6-mm) gap to be covered with trim at top, bottom, and openings. Butt adjacent panels with moderate contact. Use fasteners with prefinished heads matching paneling color.

C. Board Paneling: Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.

1. Install in full lengths without end joints.
2. Stagger end joints in random pattern to uniformly distribute joints on each wall.
3. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards. Install with uniform tight joints between boards.
4. Fasten paneling by face nailing, setting nails, and filling over nail heads.
5. Fasten paneling with trim screws, set below face and filled.
6. Fasten paneling by blind nailing through tongues.

3.5 SHELVING AND CLOTHES ROD INSTALLATION

A. Cut shelf cleats at ends of shelves about 1/2 inch less than width of shelves and sand exposed ends smooth.

B. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches o.c.

C. Install shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.

D. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.

**END OF SECTION**

**SECTION 06 41 00**

**ARCHITECTURAL WOOD CASEWORK**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Specially fabricated cabinet units.

1. Contractor's Option: Manufactured wood casework may be provided in lieu of Custom Wood Casework specified in this section. Performance, finish, wood species, and cabinet configuration must match.

B. Countertops.

C. Cabinet hardware.

1.2 REFERENCE STANDARDS

A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2014, with Errata (2016).

B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 3.1; 2016, with Errata (2017).

C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2016.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1. Ensure required submittals have been provided with sufficient time for review prior to scheduling the Preinstallation Meeting.
2. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work
   a. Require attendance by all affected installers including but not limited to
      1) Contractor's Superintendent
      2) Installer
      3) Manufacturer/Fabricator Representative
      4) Other affected Subcontractors
      5) Architect/Engineer of Record
      6) Board's Representative
3. Record minutes and distribute copies within 5 days after meeting to participants as well as Architect/Engineer of Record, Board and those affected by decisions made.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. See Section 01 33 29 - LEED Sustainable Design Reporting, when required.

C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
   1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.

D. Product Data: Provide data for hardware and accessories.

E. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet and shelf unit substrate and finish.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

   1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.

1.6 MOCK-UP

A. Provide mock-up of typical base cabinet, wall cabinet, and countertop, including hardware, finishes, and plumbing accessories.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect units from moisture damage.

1.8 FIELD CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Single Source Responsibility: Provide and install this work from single fabricator.

2.2 CABINETS

A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

B. Wood Veneer Faced Cabinet:
   1. Exposed Surfaces for Transparent Finished Cabinets: HPVA HP-1 Grade A, Northern hard White Maple, plain sliced, book-matched.
      a. Run and match grain vertically for drawer fronts, doors and fixed panels.
      b. Fabricate Work of each continuous casework unit from book matched, flitch-matched architectural plywood panel sets.
   2. Concealed Surfaces: Manufacturer's option.

C. Plastic Laminate_Faced Cabinets:
   1. Finish - Exposed Exterior Surfaces: Decorative laminate.
   2. Finish - Exposed Interior Surfaces: Decorative laminate.
   3. Finish - Semi-Exposed Surfaces: Decorative laminate
   4. Finish - Concealed Surfaces: Manufacturer's option.
   5. Edges of Doors, Drawers, and Face Frame: 3 mil PVC.
   6. Thickness and Style: As shown, or if not shown, provide 3/4" thick doors, drawer fronts and fixed panels, except where required to be thicker by Standards; and provide flush units.
   7. Cabinet Design Series: As indicated on drawings.
   8. Adjustable Shelf Loading: 50 lbs. per sq. ft.
      a. Deflection: L/144.

D. Cabinet Style: Half overlay type, except as otherwise indicated.

2.3 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

B. Solid Wood for Transparent Finishes: AWI Grade I plain sawn Northern hard whitemaple, selected for compatibility of color and grain from piece to piece.

C. Solid Wood for Opaque (Painted) Finishes: Paint grade poplar or birch.

D. Particle Board: ANSI A 208.1 composed of wood chips, medium (40-50 PSF) density, Grade M-2-Exterior Glue (no Formaldehyde), sanded faces, fire retardant treated where indicated, and where used as backing core of wall paneling (UL stamp for Class 1. rating).

E. Hardboard: ANSI A 135.4, pressed wood fibers with resin binders, tempered grade, 1/4" thick unless shown otherwise, smooth two sides where exposed.

F. Fiberboard: ANSI A208.2 composed of wood reduced to fine fibers mixed with binders and formed into panels by heat and pressure, 37 to 50 lb./cu. ft. density, grade MD-exterior glue (no Formaldehyde).

G. Thermoset Decorative Overlay Board: Particleboard specified above, or medium-density fiberboard specified above with surface of thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

H. Provide sustainably harvested wood, certified or labeled as specified in Section 01 60 00.

2.4 LAMINATE MATERIALS

A. Manufacturers:
1. Formica Corporation.
2. Panolam Industries International, Inc; Nevamar.
3. Wilsonart LLC;____: www.wilsonart.com/#sle.

B. High-Pressure Decorative Laminate (HPDL) Provide specific types as indicated.
1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, through color, color as selected.
2. Vertical Surfaces and Backer: VGS, 0.028 inch nominal thickness, through color, color as selected.

2.5 COUNTERTOPS

A. Countertops are specified in Section 12 36 00.

2.6 ACCESSORIES

A. Adhesive: Type recommended by fabricator to suit application.

B. Plastic Edge Banding: Extruded PVC, flat shaped; smooth finish; self-locking serrated tongue; of width to match component thickness.
1. Color: As selected by Architect/Engineer of Record from manufacturer's full range.
2. Use at all exposed shelf edges and as indicated.

C. Fasteners: Size and type to suit application.

D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.

E. Concealed Joint Fasteners: Threaded steel.

2.7 HARDWARE

A. Open Adjustable Shelf Supports and Brackets:
1. Adjustable Shelf Supports: Heavy-duty slotted steel, BHMA A156.9, B04102.
a. Knape & Vogt No. 87.
b. Reeve No. RV-700.
c. Or Equal.

2. Shelf Brackets: Provide heavy-duty double-and-triple-hooked steel brackets, BHMA B04112.
   a. Knape & Vogt Nos. 186 and 187.
   b. Reeve NO. RV-767.
   c. Or Equal.
3. Finish: Satin Chrome or Zinc.

B. Hooks: Hewi 513 or equal.

C. Grommets: Standard 1-1/4 inch diameter plastic grommets for cut-outs, in color to match adjacent surface.

D. Cabinet Hardware (except where Drawings indicate otherwise):
1. Adjustable Pilaster Shelf Supports and Brackets: Flush mounted pilaster type slotted steel standards, comply with BHMA B84073. Provide matching shelf rests, BHMA B84093. Multiple holes, 5mm diameter with pins matching shelf supports acceptable.
   a. Knape & Vogt Nos. 255 and 256.
   b. Sugatsune No. SP-1820 and SPB-20.
   c. Or Equal.
2. Side Pair Drawer Slides: BHMA B05053, 100 lb. rated (per pair) ball-bearing nylon rollers, 1/2" wide units, commercial grade, full extension.
   a. Accurate No. 7432 Series.
   b. Hettich Grant No. 5632.
   c. Knape & Vogt No. 1429.
3. Magnetic Cabinet Catches: BHMA, B43142, B43152 or B43162 (type as applicable) aluminum case, commercial grade.
4. Heavy-Duty Magnetic Catches: BHMA B43172, aluminum case, commercial grade, 11.0 lbs. minimum test pull (door 16" wide and wider).
5. Hinges: Institutional type, 5 knuckle, BHMA B1201
6. Pulls: Rod type, 5/16" diameter, 7/8" finger clearance, 4" screw centers.
   a. Stanley No. 4483.
   b. Hafele No. 116.39.464
   c. Or Equal
7. Drawer and Cupboard Locks: BHMA E0761.
   a. Provide on all doors and drawers, as indicated on Drawings.
8. Finish for Exposed Cabinet Hardware: Except as otherwise indicated, provide the following finish for exposed hardware comply with BHMA A156.18. For items not available in required finish, provide finish selected by Architect from those available. If more than one finish is indicated, match finish of hardware items on each "set" of casework as indicated.
   a. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.

## 2.8 SITE FINISHING MATERIALS

A. Finishing: Site finished as specified in Section 09 91 23.

2.9 FABRICATION

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
   1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
   2. Cap exposed plastic laminate finish edges with material of same finish and pattern.

2.10 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. On items to receive transparent finishes, use wood filler matching or blending with surrounding surfaces and of types recommended for applied finishes.

C. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
   1. Transparent:
      a. System - 5, Varnish, Conversion.
      b. Stain: As selected by Architect/Engineer of Record.
      c. Sheen: Satin.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify adequacy of backing and support framing.

3.2 INSTALLATION

A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

C. Use fixture attachments in concealed locations for wall mounted components.

D. Use concealed joint fasteners to align and secure adjoining cabinet units.

E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.

F. Secure cabinets to floor using appropriate angles and anchorages.

G. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.3 ADJUSTING

A. Adjust moving or operating parts to function smoothly and correctly.

3.4 CLEANING

A. Clean casework, hardware, fittings, and fixtures.

**END OF SECTION**

**SECTION 06 61 16**

**SOLID SURFACING FABRICATIONS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Solid surface window sills.

B. Solid surface wainscoting and wall surfacing.

1.2 REFERENCE STANDARDS

A. ANSI Z124.3 - American National Standard for Plastic Lavatories; 2005.

B. ANSI Z124.6 - American National Standard for Plastic Sinks; 2007.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate dimensions, thicknesses, required clearances, tolerances, materials, colors, finishes, fabrication details, field jointing, adjacent construction, methods of support, integration of plumbing and electrical components, and anchorages.

C. Product Data: Provide data on specified component products, electrical characteristics and connection requirements.

D. Samples: Submit two samples representative of each application type, 6 x 6 inch in size, illustrating color, texture, and finish.

E. Maintenance Data: Indicate list of approved cleaning materials and procedures required; list of substances that are harmful to the component materials.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Solid Surfacing Fabrications:

1. Avonite.
2. E.I. du Pont de Nemours and Company (DuPont Corian).
3. Formica Corporation.
4. LG Chemical, Ltd.
5. Samsung Chemical USA, Inc.
6. Wilsonart International Holdings, Inc.

### 2.2 MATERIALS

A. Solid Surfacing:

1. Cast, nonporous, filled polymer, not coated, laminated or of composite construction with through body colors meeting ANSI Z124.3 or ANSI Z124.6, having minimum physical and performance properties specified.
2. Superficial damage to a depth of 0.010" shall be repairable by sanding and/or polishing.
3. Thickness:
   a. Wall Surfacing and Wainscoting: 1/4 inch.
   b. Window Sills: 1/2 inch.
4. Surface Finish: Matte
5. Color: As selected by Architect/Engineer of Record from manufacturer's full range of color and finish options, refer to Drawings for basis of design colors.
6. Edge Treatment: Rabbet, beveled or eased square edge; as specified and as shown in construction drawings.

B. Provide finished products having flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84 in thickness of 3/4 inch.

C. Panel Adhesive: Manufacturer's standard neoprene-based panel adhesive comply with ANSI A136.1.

D. Sealant: As specified in 07 92 00 - Joint Sealants. Color as selected by Architect/Engineer of Record from manufacturer's full range.

E. Fasteners for Wall Cladding: Type 304 stainless steel tamper-resistant self tapping screws, of appropriate length to fasten solid surface panels to substrate and metal framing. Provide clear neoprene washers with screws.

### 2.3 FABRICATION

A. Fabricate components to greatest extent practical to sizes and shapes indicated, in accordance with approved shop drawings and manufacturer’s printed instructions and technical bulletins.

B. Provide solid surface panels in sizes as indicated in Construction Drawings.

C. Provide factory cutouts for electrical devices, access panels and any other installed items penetrating solid surface installations.

D. Rout and finish component edges with clean, sharp returns.

1. Create bevel/chamfer at top and bottom edges of panels and at outer corners.
2. Rabbet sides of panels for lap jointing with adjacent panels. Completed lap joints shall have 3/16" reveal gap to allow for thermal expansion and movement.
3. Repair or reject defective and inaccurate work.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that joint preparation and affected dimensions are acceptable.

B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.2 PREPARATION

A. Provide anchoring devices for installation.

B. Provide templates and rough-in measurements.

3.3 INSTALLATION

A. Install components in accordance with shop drawings and manufacturer's instructions.

B. Align work plumb and level.

C. Rigidly anchor to substrate to prevent misalignment.

3.4 TOLERANCES

A. Maximum Variation From True Dimension: 1/8 inch.

B. Maximum Offset From True Position: 1/8 inch.

3.5 CLEANING

A. Clean surfaces in accordance with manufacturer's instructions.

3.6 PROTECTION

A. Cover and protect completed fabrications during remainder of construction. Do not permit construction near unprotected surfaces.

**END OF SECTION**

**SECTION 07 01 50.19**

**PREPARATION FOR REROOFING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Full tear-off of entire roof system.
2. Removal of flashings and counterflashings.
3. Temporary roofing.

B. Related Requirements:

1. Section 01 10 00 "Summary" for use of premises and for phasing requirements.
2. Section 01 50 00 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for reroofing preparation.
3. Section 02 82 15 “Asbestos Abatement – Exteriors” for requirements regarding handling and disposal of asbestos containing materials.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

B. Full Roof Tear-off: Removal of existing roofing system down to existing roof deck.

1.4 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting removal Work, conduct conference at Project site

1. Meet with the CHA’s Designated Representative, Architect, testing and inspecting agency representative, roofing Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing tear-off, including, but not limited to, the following:

a. Reroofing preparation, including roofing system manufacturer's written instructions.
b. Temporary protection requirements for existing roofing system components that are to remain.
c. Existing roof drains and roof drainage during each stage of reroofing, and roof-drain plugging and plug removal.
d. Construction schedule and availability of materials, Installer's personnel, equipment, and facilities needed to avoid delays.
e. Existing roof deck conditions requiring Architect notification.
f. Existing roof deck removal procedures and CHA notifications.
g. Condition and acceptance of existing roof deck and base flashing substrate for reuse.
h. Structural loading limitations of roof deck during reroofing.
i. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that affect reroofing.
j. HVAC shutdown and sealing of air intakes.
k. Shutdown of fire-suppression, -protection, and -alarm and -detection systems.
l. Asbestos removal and discovery of asbestos-containing materials.
m. Governing regulations and requirements for insurance and certificates if applicable.
n. Existing conditions that may require Architect notification before proceeding.
o. Cell phone equipment relocation.

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Temporary Roofing Submittal: Product data and description of temporary roofing system.

1. Vapor Retarder specified in Section 07 54 23- Thermoplastic-Polyolefin (TPO) Roofing, to act as temporary roof, if to remain exposed for a period of time submit a letter from roofing manufacturer stating acceptance of the length of schedule exposed time period.

## 1.6 INFORMATIONAL SUBMITTALS

A. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces that might be misconstrued as having been damaged by reroofing operations.

1. Submit before Work begins.

## 1.7 CLOSEOUT SUBMITTALS

A. Certified statement from manufacturer for existing warranted roof system stating that existing roof warranty has not been affected by Work performed under this Section.

1.8 QUALITY ASSURANCE

A. Installer Qualifications**:** Approved by warrantor and licensed to perform asbestos abatement in the state or jurisdiction where Project is located.

B. Regulatory Requirements:

1. Comply with governing EPA notification regulations before beginning roofing removal.
2. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.9 FIELD CONDITIONS

A. Existing Roofing System**: Built-up asphalt** roofing.

B. The CHA will occupy portions of building immediately below reroofing area.

1. Conduct reroofing so the CHA's operations are not disrupted.
2. Provide the CHA's Designated Representative with not less than 72 hours' written notice of activities that may affect the CHA's operations.
3. Coordinate work activities daily with the CHA's Designated Representative so the CHA has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.

C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.

D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

E. Conditions existing at time of inspection for bidding will be maintained by the CHA as far as practical.

F. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

1. Remove only as much roofing in one day as can be made watertight in the same day.

G. Hazardous Materials: It is not expected that hazardous materials, such as asbestos-containing materials, will be encountered in the Work.

1. Hazardous materials will be removed by the CHA before start of the Work.
2. Existing roof will be left no less watertight than before removal.
3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and the CHA's Designated Representative.

a. Hazardous materials will be removed by the CHA under a separate contract.

H. Hazardous Materials: A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

1. Hazardous material remediation is specified elsewhere in the Contract Documents.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials except according to procedures specified elsewhere in the Contract Documents.
3. Coordinate reroofing preparation with hazardous material remediation to prevent water from entering existing roofing system or building.

**PART 2 - PRODUCTS**

2.1 TEMPORARY ROOFING MATERIALS

1. Use Vapor Retarder specified unless otherwise indicated.

2.2 INFILL AND REPLACEMENT MATERIALS

A. Use infill materials matching existing roofing system materials unless otherwise indicated.

1. Infill materials are specified in **[Section 07 52 16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing"]** unless otherwise indicated.

B. Wood blocking, curbs, and nailers are specified in Section 06 10 00 "Rough Carpentry."

C. Fasteners: Factory-coated steel fasteners with metal or plastic plates listed in FM Approvals' RoofNav, and acceptable to new roofing system manufacturer.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Protect existing roofing system that is not to be reroofed.
2. Limit traffic and material storage to areas of existing roofing that have been protected.
3. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
4. Comply with requirements of existing roof system manufacturer's warranty requirements.

B. Seal or isolate windows that may be exposed to airborne substances created in removal of existing materials.

C. Shut off rooftop utilities and service piping before beginning the Work.

D. Contact cell phone provider for required safety procedures when working next to cell phone sectors and equipment.

E. Test existing roof drains to verify that they are not blocked or restricted.

1. Immediately notify Architect of any blockages or restrictions.

F. Coordinate with the CHA to shut down air-intake equipment in the vicinity of the Work.

1. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

G. During removal operations, have sufficient and suitable materials on-site to facilitaterapid installation of temporary protection in the event of unexpected rain.

H. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday.

1. Prevent debris from entering or blocking roof drains and conductors.

a. Use roof-drain plugs specifically designed for this purpose.
b. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

2. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding.

a. Do not permit water to enter into or under existing roofing system components that are to remain.

3.2 ROOF TEAR-OFF

A. Notify the CHA's Designated Representative each day of extent of roof tear-off proposed for that day.

B. Lower removed roofing materials to ground and onto lower roof levels, using dust-tight chutes or other acceptable means of removing materials from roof areas.

C. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing using a power broom.

D. Full Tear-off: Where indicated on Drawings, remove existing roofing and other roofing system components down to the existing roof deck.

1. Remove base flashings and counter flashings.
2. Remove perimeter edge flashing and gravel stops.
3. Remove copings.
4. Remove expansion-joint covers.
5. Remove flashings at pipes, curbs, mechanical equipment, and other penetrations.
6. Remove roof drains indicated on Drawings to be removed.
7. Remove wood blocking, curbs, and nailers.
8. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry.

    a. Remove unadhered bitumen, unadhered felts, and wet felts.
9. Coordinate the relocation/ the existing call phone platform cable trays and sectors

3.3 DECK PREPARATION

A. Inspect deck after tear-off of roofing system.

B. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify the Architect.

1. Do not proceed with installation until directed by the Architect.

C. If deck surface is unsuitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Architect.

1. Do not proceed with installation until directed by the Architect.

3.4 TEMPORARY ROOFING

A. Install temporary roofing over area to be reroofed. Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches (90 and 150 mm), respectively.

3.5 BASE FLASHING REMOVAL

A. Remove existing base flashings.

1. Clean substrates of contaminants, such as asphalt, sheet materials, dirt, and debris.

B. Remove metal counterflashings.

C. Per Drawings, replace parapet frame, wood blocking, curbs, and nailers. All wood elements shall be

3.6 DISPOSAL

A. Collect demolished materials and place in containers.

1. Promptly dispose of demolished materials.
2. Do not allow demolished materials to accumulate on-site.
3. Storage or sale of demolished items or materials on-site is not permitted.

B. Transport and legally dispose of demolished materials off the CHA's property in accordance with Section 01 74 19 “Construction Waste Management and Disposal”.

**END OF SECTION**

**SECTION 07 11 13**

**BITUMINOUS DAMPPROOFING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cold-applied, emulsified-asphalt dampproofing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide protection course and auxiliary materials recommended in writing by manufacturer of primary materials.

2.2 PERFORMANCE REQUIREMENTS

A. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. APOC, Inc; a division of Gardner Industries.
2. BASF Corporation.
3. Henry Company.
4. Karnak Corporation.
5. W.R. Meadows, Inc.

B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

2.4 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

C. Asphalt-Coated Glass Fabric: ASTM D 1668/D 1668M, Type I.

D. Patching Compound: of type recommended in writing by dampproofing manufacturer.

E. Protection Course: ASTM D 6506, semirigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

1. Thickness: Nominal 1/8 inch (3 mm).

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for surface smoothness, maximum surface moisture content, and other conditions affecting performance of the Work.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for dampproofing application.

B. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

C. Clean substrates of projections and substances detrimental to dampproofing work; fill voids, seal joints, and remove bond breakers if any.

D. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections.

## 3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.

1. Apply dampproofing to provide continuous plane of protection.
2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches (150 mm) over outside face of footing.

1. Extend dampproofing 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch- (200-mm-) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

## 3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations: Apply one fibered brush or spray coat at not less than 3 gal./100 sq. ft. (1.2 L/sq. m).

B. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft. (0.5 L/sq. m).

## 3.5 PROTECTION COURSE INSTALLATION

A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.

1. Install protection course within 24 hours of dampproofing installation (while coating is tacky) to ensure adhesion.

## 3.6 PROTECTION

A. Correct dampproofing that does not comply with requirements; repair substrates, and reapply dampproofing.

**END OF SECTION**

**SECTION 07 18 00**

**TRAFFIC COATINGS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes traffic coatings for the following applications:

1. Pedestrian traffic.
2. Equipment-room floor.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include installation instructions and details, material descriptions, dry or wet film thickness requirements, and finish.

B. Shop Drawings: For traffic coatings.

1. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions that are not included in manufacturer's product data.

C. Samples for Verification: For each type of exposed finish, prepared on rigid backing.

1. Provide stepped Samples on backing to illustrate buildup of traffic coatings.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of traffic coating.

C. Sample Warranty: For manufacturer's warranty.

### 1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For traffic coatings to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F (5 deg C), when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.

B. Do not install traffic coating until items that penetrate membrane have been installed.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace traffic coating that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Adhesive or cohesive failures.
b. Abrasion or tearing failures.
c. Surface crazing or spalling.
d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.

2. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Source Limitations:

1. Obtain primary traffic-coating materials, including primers, from traffic-coating manufacturer. Obtain accessory materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of types and from sources recommended in writing by primary material manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Material Compatibility: Provide primers; base coat, intermediate coat, and topcoat; and accessory materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. VOC Content of Interior Coatings: Coatings used inside the weatherproofing system shall comply with the following:

1. Traffic Coatings shall have a VOC content of 100 g/L or less.
2. Primers, Sealers, and Undercoaters shall have a VOC content of 200 g/L or less.

## 2.3 TRAFFIC COATING

A. Traffic Coating: Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, water-resistant membrane system with integral wearing surface for pedestrian traffic and equipment-room floor; according to ASTM C 957/C 957M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BASF Corporation.
b. Carlisle.
c. Euclid Chemical Company (The); an RPM company.
d. Pecora Corporation.
e. Tremco Incorporated.

B. Primer: Liquid primer as recommended in writing for substrate and conditions by traffic-coating manufacturer.

C. Preparatory and Base Coats: Polyurethane.

1. Thicknesses: Minimum film thickness as recommended in writing by manufacturer for substrate and service conditions indicated.

D. Topcoat: Polyurethane.

1. Thicknesses: Minimum film thickness as recommended in writing by manufacturer for substrate and service conditions indicated, measured excluding aggregate.
2. Aggregate Content: As recommended in writing by traffic-coating manufacturer for substrate and slip-reducing service conditions.
3. Color: As selected by Architect from manufacturer's full range.

E. Aggregate: Manufacturer's standard aggregate for each use indicated of particle sizes, shape, and minimum hardness recommended in writing by traffic-coating manufacturer.

## 2.4 ACCESSORY MATERIALS

A. Joint Sealants: As recommended in writing by traffic-coating manufacturer, and compatible with system and adjacent materials.

1. VOC Content of Interior Sealants: Sealants used inside the weatherproofing system shall have a VOC content of 250 g/L or less.

B. Sheet Flashing: Nonstaining sheet material recommended in writing by traffic-coating manufacturer.

C. Adhesive: Contact adhesive recommended in writing by traffic-coating manufacturer.

D. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic-coating manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, surface smoothness, and other conditions affecting performance of traffic-coating work.

B. Verify that substrates are visibly dry and free of moisture.

1. Test for moisture content by method recommended in writing by traffic-coating manufacturer.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of traffic-coating work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Begin coating application only after substrate construction and penetrating work have been completed.
2. Begin coating application only after minimum concrete-curing and -drying period recommended in writing by traffic-coating manufacturer has passed and after substrates are dry.
3. Application of coating indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

A. Clean and prepare substrates according to ASTM C 1127 and manufacturer's written instructions to produce clean, dust-free, dry substrate for traffic-coating application. Remove projections, fill voids, and seal joints if any, as recommended in writing by traffic-coating manufacturer.

B. Priming: Unless manufacturer recommends in writing against priming, prime substrates according to manufacturer's written instructions.

1. Limit priming to areas that will be covered by traffic-coating material on same day. Reprime areas exposed for more time than recommended by manufacturer.

C. Schedule preparation work so dust and other contaminants from process do not fall on wet, newly coated surfaces.

D. Mask adjoining surfaces not receiving traffic coatings to prevent overspray, spillage, leaking, and migration of coatings. Prevent traffic-coating materials from entering deck substrate penetrations and clogging weep holes and drains.

E. Concrete Substrates: Mechanically abrade surface to a uniform profile acceptable to manufacturer, according to ASTM D 4259. Do not acid etch.

1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
2. Remove concrete fins, ridges, and other projections.
3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

## 3.3 TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written instructions.

B. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.

## 3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

B. Apply reinforcing strip in traffic-coating system where recommended in writing by traffic-coating manufacturer.

## 3.5 TRAFFIC-COATING APPLICATION

A. Apply traffic coating according to ASTM C 1127 and manufacturer's written instructions.

B. Apply coats of specified compositions for each type of traffic coating at locations as indicated on Drawings.

C. Verify that wet-film thickness of each coat complies with requirements every 100 sq. ft. (9 sq. m).

D. Uniformly broadcast and embed aggregate in each coat indicated to receive aggregate according to manufacturer's written instructions. After coat dries, sweep away excess aggregate.

E. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated; omit aggregate on vertical surfaces.

F. Cure traffic coatings. Prevent contamination and damage during coating application and curing.

3.6 FIELD QUALITY CONTROL

A. Final Traffic-Coating Inspection: Arrange for traffic-coating manufacturer's technical personnel to inspect membrane installation on completion.

B. Waterproofing will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 PROTECTING AND CLEANING

A. Protect traffic coatings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

**END OF SECTION**

**SECTION 07 21 00**

**THERMAL INSULATION**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board.
2. Polyisocyanurate foam-plastic board.
3. Glass-fiber board.
4. Vacuum insulated panel c.v.i.p

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

**PART 2 - PRODUCTS**

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded polystyrene boards in this article are also called "XPS boards."

B. Extruded Polystyrene Board, Type IV: ASTM C 578, Type IV, 25-psi (173-kPa) minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. DiversiFoam Products.
b. Dow Chemical Company (The).
c. Owens Corning.

2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

C. Extruded Polystyrene Board, Type V: ASTM C 578, Type V, 100-psi (690-kPa) minimum compressive strength; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Chemical Company (The).
b. Owens Corning.

2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD

A. Polyisocyanurate Board, Foil Faced: ASTM C 1289, foil faced, Type I, Class 1 or 2.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlisle Coatings & Waterproofing Inc.
b. Dow Chemical Company (The).
c. Johns Manville; a Berkshire Hathaway company.

2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

B. Polyisocyanurate Board, Glass-Fiber-Mat Faced: ASTM C 1289, glass-fiber-mat faced, Type II, Class 2.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carlisle Coatings & Waterproofing Inc.
    b. Firestone Building Products.

2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.3 GLASS-FIBER BOARD

A. lass-Fiber Board, Unfaced: ASTM C 612, Type IA; unfaced, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84, passing ASTM E 136 for combustion characteristics. Nominal density of 2.25 lb/cu. ft (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).

    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        a. CertainTeed Corporation.
        b. Johns Manville; a Berkshire Hathaway company.
        c. Owens Corning.

B. Glass-Fiber Board, Faced: ASTM C 612, Type IA; faced on one side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84. Nominal density of 2.25 lb/cu. ft. (36 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).

    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        a. CertainTeed Corporation.
        b. Johns Manville; a Berkshire Hathaway company.
        c. Owens Corning.

C. Glass-Fiber Board, Unfaced: ASTM C 612, Type IA; unfaced, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84, passing ASTM E 136 for combustion characteristics. Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. CertainTeed Corporation.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Owens Corning.

D. Glass-Fiber Board, Faced: ASTM C 612, Type IA; faced on one side with foil-scrim-kraft or foil-scrim-polyethylene vapor retarder, with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84. Nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. CertainTeed Corporation.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Owens Corning.

## 2.4 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer inplace.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AGM Industries, Inc.
   b. Gemco.

2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.762 mm) thick by 2 inches (50 mm) square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation.

B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AGM Industries, Inc.
b. Gemco.

2.5 ACCESSORIES

A. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse

and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION**

**SECTION 07 21 29**

**SPRAYED INSULATION**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Glass fiber acoustic insulation applied to underside of structure.

1.2 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.

B. ASTM C1014 - Standard Specification for Spray-Applied Mineral Fiber Thermal and Sound Absorbing Insulation; 2017.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

D. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace At 750 Degrees C; 2016a.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on materials, describing insulation properties.

C. Certificates: Certify that products of this section meet or exceed specified requirements.

D. Manufacturer's Qualification Statement.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

1.5 FIELD CONDITIONS

A. Maintain acceptable ambient and substrate surface temperatures prior to, during, and after installation of insulation materials to comply with manufacturer's requirements.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Glass Fiber Sprayed Insulation:

1. MonoGlass
2. Thermacoustic

2.2 MATERIALS

A. Glass Fiber: Comply with ASTM C1014.

1. Thermal Resistance (R-value: 12.25, at 3-1/2 inch thick when tested in accordance with ASTM C518 at 75 degrees F temperature.
2. Density: 2.8 lb/cu ft.
3. Noise Reduction Coefficient (NRC): 0.80 for 1 inch thickness.
4. Moisture Absorption: Maximum 5 percent by weight.
5. Flame Spread and Smoke Developed Index: 0/0, when tested in accordance with ASTM E84.
6. Combustibility: Passing ASTM E136.

2.3 ACCESSORIES

A. Primer: As required by insulation manufacturer

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that surfaces are clean, dry, and free of matter that may inhibit adhesion.

B. Verify that ceiling hangers and supporting clips have been are installed correctly.

C. Verify other work on and within spaces to be insulated is complete prior to application.

D. Commencement of insulation installation constitutes acceptance of conditions.

3.2 PREPARATION

A. Mask and protect adjacent surfaces from overspray or damage. Remove fixtures or equipment that do not allow for proper installation of insulation.

B. Apply primer in accordance with manufacturer's instructions.

3.3 INSTALLATION

A. Install sprayed insulation in accordance with manufacturer's instructions.

B. Install sprayed insulation to a uniform monolithic density without voids.

C. Install to achieve acoustical value as indicated.

D. Tamp wet sprayed insulation surface to improve adhesion and to achieve a smooth surface.

3.4 FIELD QUALITY CONTROL

A. Independent agency field inspection will be provided under provisions of Section 01 40 00 - Quality Requirements.

B. Inspection will include verification of insulation thickness and density.

3.5 PROTECTION

A. Do not permit subsequent construction work to disturb applied sprayed insulation.

3.6 CLEANING

A. Remove any temporary masking or protective covers installed in preparation for sprayed insulation installation.

B. Reinstall any temporarily removed equipment or fixtures removed in preparation for spayed insulation installation.

**END OF SECTION**

**SECTION 07 25 00**

**WEATHER BARRIERS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Air barrier sheet, self-adhered.
2. Air barrier, fluid applied.

### 1.3 DEFINITIONS

A. Weather Barrier: Assemblies that form either water-resistive barriers, air barriers, or vapor retarders.

B. Air Barrier: Air tight barrier made of material that is relatively air impermeable but water vapor permeable, both to the degree specified, with sealed seams and with sealed joints to adjacent surfaces. Note: For the purposes of this specification, vapor impermeable air barriers are classified as vapor retarders.

C. Vapor Retarder: Air tight barrier made of material that is relatively water vapor impermeable, to the degree specified, with sealed seams and with sealed joints to adjacent surfaces.

1. Water Vapor Permeance: For purposes of conversion, 57.2 ng/(Pa s sq m) = 1 perm.

D. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture resistant, to the degree specified, intended to be installed to shed water without sealed seams.

### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review products, and details at terminations, openings and penetrations.

### 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show details of building air barrier at terminations, openings, and penetrations. Show details of flexible flashing applications.

1.6 INFORMATION SUBMITTALS

A. ABAA Field Quality Control Submittals: Submit third-party reports of testing and inspection required by ABAA QAP.

B. ABAA Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials

C. ABAA Installer Qualification: Submit documentation of current contractor accreditation and current installer certification; keep copies of each contractor accreditation and installer certification on site during and after installation, and present on-site documentation upon request.

D. Compatibility: Submit letter from manufacturer stating that materials proposed for use are permanently chemically compatible and adhesively compatible with adjacent construction and that cleaning materials used during installation are chemically compatible with adjacent materials construction.

E. Field Test Results of Mockup: Submit tests results of air leakage test, water leakage test, and adhesion test of mockup in accordance with specified standards, including retesting if initial results are not satisfactory.

1.7 QUALITY ASSURANCE

A. Air Barrier Association of America (ABAA) Quality Assurance Program (QAP):

1. Installer Qualification: Use accredited contractor, certified installers, evaluated materials, and third-party field quality control audit.
2. Manufacturer Qualification: Use evaluated materials from a single manufacturer regularly engaged in air barrier material manufacture, and use secondary materials approved in writing by primary material manufacturer.

B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

C. Mockups: Building mockup of barrier on exterior wall assembly where directed by Architect/Engineer of Record, minimum 10 ft. by 10 ft.

1. Coordinate construction of mockup to permit inspection and testing before external insulation and cladding is installed.
2. Mockup Tests for Air and Water Infiltration: Test mockup at Contractor's expense for air and water infiltration in accordance with ASTM E1186, ASTM E783, and ASTM E1105. Use smoke tracer to locate sources of air leakage. If deficiencies are found, reconstruct mockup and retest until satisfactory results are obtained. Deficiencies include air leakage beyond values specified, uncontrolled water leakage, unsatisfactory workmanship.

a. Perform the air leakage tests and water penetration test of mockup prior to installation of cladding and trim but after installation of all fasteners for cladding and trim and after installation of other penetrating elements have been flashed in.
b. Perform additional tests as necessary to achieve specified performance criteria after initial testing.

3. Mockup Tests for Membrane Adhesion: Test mockup at Contractor's expense of membrane for adhesion in accordance with ASTM D4541, using a Type 1 pull tester, except that the disk used shall be 100 mm in diameter and the membrane shall be cut through to separate the material attached to the disk from the surrounding material. Perform test after curing period recommended by the manufacturer. Record mode of failure and area which failed in accordance with ASTM D4541.

a. Modify products or procedures and retest until successful

1.8 WARRANTY

A. Installation Warranty: Provide installer's 10 year warranty from date of Substantial Completion, including all components of the air and vapor barrier assembly, against failures including loss of air tight seal, loss of watertight seal, loss of adhesion, loss of cohesion, and failure to cure properly

**PART 2 - PRODUCTS**

2.1 AIR BARRIER MATERIALS (WATER VAPOR PERMEABLE AND WATER-RESISTIVE)

A. Air Barrier Sheet, Self-Adhered:

1. Air Permeance: 0.004 cubic feet per minute per square foot, maximum, when tested in accordance with ASTM E2178.
2. Water Vapor Permeance: 10 perms, minimum, when tested in accordance with ASTM E96/E96M Procedure A (desiccant procedure).
3. Water Penetration Resistance Around Nails: Pass, when tested in accordance with ASTM D1970/D1970M (modified).
4. Ultraviolet (UV) and Weathering Resistance: Approved in writing by manufacturer for up to 90 days of weather exposure.
5. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less (Class A), when tested in accordance with ASTM E84.
6. Water Resistance: Comply with applicable water-resistive requirements of ICC-ES AC38.
7. Seam and Perimeter Tape: As recommended by sheet manufacturer.
8. Manufacturers:

a. Carlisle Coatings and Waterproofing.
b. GCP Applied Technologies (formerly W.R. Grace).
c. Henry Company
d. Tremco
e. W.R. Meadows

B. Air Barrier, Fluid Applied: Vapor permeable, elastomeric waterproofing.

1. Air Barrier Coating:

a. Dry Film Thickness (DFT): 10 mil, 0.010 inch, minimum.
b. Air Permeance: 0.001 cubic feet per minute per square foot, maximum, when tested in accordance with ASTM E2178.
c. Water Vapor Permeance: 10 perms, minimum, when tested in accordance with ASTM E96/E96M, Procedure B.
d. Ultraviolet (UV) and Weathering Resistance: Approved in writing by manufacturer for up to six months of weather exposure after application.
e. Elongation: 300 percent, minimum, when tested in accordance with ASTM D412.
f. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
g. Nail Sealability: Pass, when tested in accordance with ASTM D1970/D1970M.
h. Code Acceptance: Comply with applicable requirements of ICC-ES AC212.
i. Sealants, Tapes and Accessories: As recommended by coating manufacturer.

2. Manufacturers:

a. Carlisle Coatings and Waterproofing.
b. GCP Applied Technologies (formerly W.R. Grace).
c. Henry Company
d. Tremco
e. W.R. Meadows

2.2 VAPOR RETARDER MATERIALS (AIR BARRIER AND WATER-RESISTIVE)

A. Vapor Retarder Sheet: ASTM D1970/D1970M

1. Type: Rubberized asphalt bonded to thermoplastic sheet, self-adhesive.
2. Thickness: 40 mil, 0.040 inch, nominal.
3. Water Vapor Permeance: 0.1 perm, maximum, when tested in accordance with ASTM E96/E96M.
4. Seam and Perimeter Tape: As recommended by sheet manufacturer.
5. Manufacturers:

a. Carlisle Coatings and Waterproofing.
b. GCP Applied Technologies (formerly W.R. Grace).
c. Henry Company
d. Tremco
e. W.R. Meadows

B. Vapor Retarder Coating: Liquid applied, resilient, UV-resistant coating and associated joint treatment.

1. Water Vapor Permeance: 0.1 perm, maximum, when tested in accordance with ASTM E96/E96M.
2. VOC Content: Less than 50 g per L when tested in accordance with 40 CFR 59, Subpart D (EPA Method 24).

3. Code Acceptance: Comply with applicable requirements of ICC-ES AC212.
4. Suitable for use on concrete, masonry, plywood and gypsum sheathing.
5. Joint Preparation Treatment: Coating manufacturer's recommended method, either tape or reinforcing mesh saturated with coating material.
6. Manufacturers:

    a. Carlisle Coatings and Waterproofing.
    b. GCP Applied Technologies (formerly W.R. Grace).
    c. Henry Company
    d. Tremco
    e. W.R. Meadows

7. Joint Filler: As recommended by coating manufacturer and suitable to the substrate

2.3 ACCESSORIES

A. Sealants, Tapes, and Accessories for Sealing Weather Barrier and Sealing Weather Barrier to Adjacent Substrates: As specified or as recommended by weather barrier manufacturer.

B. Flexible Flashing: Self-adhesive sheet flashing as recommended by weather barrier manufacturer and complying with ASTM D1970/D1970M, except slip resistance requirement is waived if not installed on a roof.

1. Composition: Butyl rubber sheet laminated to elasticized polyethylene sheet

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that surfaces and conditions are ready to accept the work of this section.

B. Commencement of weather barrier installation constitutes acceptance of conditions

3.2 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

B. Clean and prime substrate surfaces to receive adhesives in accordance with manufacturer's instructions.

3.3 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Air Install continuous air tight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.

C. Vapor Retarders: Install continuous air tight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.

D. Mechanically Fastened Sheets - On Exterior:

1. Install after sheathing is installed and before windows and doors are installed.
2. Install lower level sheets prior to upper level sheets to ensure shingle-fashion to shed water, with seams generally horizontal.
3. Extend bottom edge of sheets 2 inches over sill plate and seal barrier to the foundation with polyurethane, elastomeric, or latex sealant.
4. Ensure barrier is plumb level with foundation, and unroll extending air infiltration barrier over window and door openings.
5. Overlap seams as recommended by manufacturer but at least 6 inches.
6. Overlap at outside and inside corners as recommended by manufacturer but at least 12 inches.
7. Attach air infiltration barrier to sheathing 12" to 18" on vertical stud line with screws having washers.
8. Install air barrier and vapor retarder UNDER jamb flashings.
9. Install head flashings under weather barrier.
10. At openings to be filled with frames having nailing flanges, wrap excess sheet into opening; at head, seal sheet over flange and flashing.
11. Seal all horizontal and vertical seams according to manufacturer's written instructions.
12. Seal a patch over all tears and cuts according to manufacturer's written instructions.

E. Self-Adhered Sheets:

1. Prepare substrate in manner recommended by sheet manufacturer; fill and tape joints in substrate and between dissimilar materials.
2. Lap sheets shingle-fashion to shed water and seal laps air tight.
3. Once sheets are in place, press firmly into substrate with resilient hand roller; ensure that laps are firmly adhered with no gaps or fishmouths.
4. Use same material, or other material approved by sheet manufacturer for the purpose, to seal to adjacent construction and as flashing.
5. At wide joints, provide extra flexible membrane allowing joint movement.

F. Coatings:

1. Prepare substrate in manner recommended by coating manufacturer; treat joints in substrate and between dissimilar materials as recommended by manufacturer.
2. Where exterior masonry veneer is to be installed, install masonry anchors before installing weather barrier over masonry; seal around anchors air tight.
3. Mastic Coating: Install by trowel or roller to minimum thickness of 1/4 inch; use sheet seal to join to adjacent construction, seal air tight with sealant.
4. Use flashing to seal to adjacent construction and to bridge joints.

G. Openings and Penetrations in Exterior Weather Barriers:

1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto weather barrier and at least 6 inches up jambs; mechanically fasten stretched edges.

2. At openings to be filled with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches wide; do not seal sill flange.
3. At openings to be filled with non-flanged frames, seal weather barrier to each side of opening framing, using flashing at least 9 inches wide, covering entire depth of framing.
4. At head of openings, install flashing under weather barrier extending at least 2 inches beyond face of jambs; seal weather barrier to flashing.
5. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
6. Service and Other Penetrations: Form flashing around penetrating item and seal to weather barrier surface.

H. Install window/door flashings AFTER installation of air filtration as follows:

1. Make a modified "I-cut" in the Barrier.
2. Cut a flap above the rough opening to allow head flashing installation.
3. Fold side and bottom flaps into rough opening and secure. Flip head flap up and temporarily secure.
4. Cut sill-flashing tape at least 12" longer than width of rough opening sill.
5. Remove first piece of release paper, align edge of sill flashing with inside edge of sill, and adhere into rough opening across sill and up jambs (minimum 6"). Sill flashing should not wrap onto interior surface of framing.
6. Remove second release paper.
7. Fan flexible tape at bottom corners onto face of wall.
8. Firmly press sill flashing to insure full adhesion.
9. Secure edges of bottom corners with approved sealing tape or mechanical fasteners.
10. Apply continuous bead of caulk to wall or backside of window mounting flange across jambs and head. Do not caulk across sill.
11. Install window/door according to manufacturer's instructions.
12. Remove release papers and install both jamb flashings overlapping entire mounting flange. Extend jamb flashings 6-inches above top of rough opening to below bottom of sill flashing.
13. Remove release papers and install head flashing overlapping entire mounting flange. Head flashing should extend beyond outside edges of both jamb flashings.
14. Flip head flap down over the head flashing.
15. Secure flap above window with approved sealing tape.
16. Caulk (using backer rod if necessary) to seal rear of window/door frame to rough opening.

## 3.4 FIELD QUALITY CONTROL]

A. Coordination of ABAA Tests and Inspections:

1. Provide testing and inspection required by ABAA QAP.
2. Notify ABAA in writing of schedule for air barrier work, and allow adequate time for testing and inspection.
3. Cooperate with ABAA testing agency.
4. Allow access to air barrier work areas and staging.
5. Do not cover air barrier work until tested, inspected, and accepted.

B. Do not cover installed weather barriers until required inspections have been completed.

C. Obtain approval of installation procedures by the weather barrier manufacturer based on a mock-up installed in place, prior to proceeding with remainder of installation.

***D.*** Take digital photographs of each portion of the installation prior to covering up**..**

E. The CHA's Inspection: At the CHA's option, the CHA may engage a qualified independent testing and inspection agency. Cooperate with the CHA's inspection agency. Allow access to work areas and staging. Notify the CHA's Designated Representative in writing of schedule for Work of this Section to allow sufficient time for observation. Do not cover Work of this Section until testing and inspection is accepted.

F. Testing Method: Testing method shall include Bubble Gun Testing per ASTM E1186, Adhesion Testing per ASTM D4541, and Thickness Testing per manufacturer.

3.5 PROTECTION

A. Do not leave materials exposed to weather longer than recommended by manufacturer.

**END OF SECTION**

**SECTION 07 42 13**

**FORMED METAL WALL PANELS**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. The extent of panel system work is indicated on the drawings and in these specifications.
2. Panel system requirements include the following components:
   a. Aluminum-faced composite panels with mounting system. Panel mounting system including anchorages, furring, fasteners, gaskets and sealants, related flashing adapters and masking for a complete installation.
   b. Panel manufacturer recommends that system should include shop-installed aluminum stiffeners on all panels of 20 square feet or larger. Minimum stiffener recommendation is one per 20 square feet of panel area.
   c. Parapet coping, column covers, soffits, sills, border and filler items may be indicated as integral components of the panels system or as designed.
   d. All flashing metal required shall be provided by the panel manufacturer.

B. Related Documents

1. Drawings and general provisions of the contract, including general and supplementary conditions, Division 1 specification sections and technical specification Divisions 2 through 16, apply to this section.

C. Related Sections

1. 051200 “Structural Steel Framing”
2. 061000 “Rough Carpentry”
3. 072100 “Thermal Insulation”
4. 076200 “Sheet Metal Flashing and Trim”
5. 079200 “Joint Sealants”
6. 092000 “Plaster and Gypsum Board”

### 1.2 QUALITY ASSURANCE

A. Composite panel manufacturer shall have a minimum of 15 years’ architectural experience in the manufacture of this product and be located within the continental USA.

B. It is recommended that fabrication and installation of composite panels shall be from a single source. If not single source, both panel fabricator and the installer must show proof of past successful collaboration.

C. Coordinate fabrication schedule with construction progress as directed by the contractor to avoid delay of work.

D. Shop drawings shall show the preferred joint details providing a watertight and structurally sound wall panel system that allows no uncontrolled water penetration, on the inside face of the panel system as determined by ASTM E331.

E. Maximum deviation from vertical and horizontal alignment of erected panels: 6 mm (1/4”) in 6 m (20’) non-accumulative.

F. Panel fabricator and installer shall assume undivided responsibility for all components of the exterior panel system, including but not limited to, attachment to sub-construction, panel-to-panel joinery, panel-to-dissimilar-material joinery and joint seal associated with the panel system.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)
1. ASTM E330: Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
2. ASTM E283: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
3. ASTM D1781: Standard Test Method for Climbing Drum Peel Test for Adhesives.
4. ASTM E84: Standard Test Method for Surface-Burning Characteristics of Building Materials.
5. ASTM E283: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
6. ASTM D3363: Standard Test Method for Film Hardness by Pencil Test.
7. ASTM D2794: Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
8. ASTM D3359: Standard Test Methods for Measuring Adhesion by Tape Test.
9. ASTM D2247: Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
10. ASTM B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.
11. ASTM D822: Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
12. ASTM D1308: Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
13. ASTM D1735: Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus.
14. ASTM D1929: Standard Test Method for Determining Ignition Temperature of Plastics.
15. ASTM D635: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in Horizontal Position

B. Underwriters Laboratories (UL)

1. UL 1715: Room Fire Test Standard for Interior of Foam Plastic Systems. Standard for Fire Test of Interior Finish Material

C. American Architectural Manufacturers Association

1. AAMA-2605 Coil Coating Aluminum Substrates. High Performance Organic Coatings On Coil Coated Architectural Aluminum Substrates

D. National Fire Protection Association (Excludes Face Fastened Solution System)

1. NFPA 285: Standard Method of Test for the Evaluation of Fire Propagation Characteristics of Exterior Non-Load Bearing Wall Assemblies Containing Combustible Components.
2. Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

1.4 SUBMITTALS

A. Submittals shall be in conformance with Section 01 33 00: Submittal Procedures.

B. Samples

1. Panel Assembly: Two samples of each type of assembly, 304 mm (12”) x 304 mm (12”) minimum.
2. Two samples of each color or finish selected, 76 mm (3”) x 102 mm (4”) minimum.
3. Custom-color samples shall contain drawdown lines. Sizes for custom-color samples are limited.

1.5 WARRANTY

A. The fabricator and installer will warrant the wall system for a period of 1 year that the fabrication and installation workmanship will be free from defects.

B. The aluminum composite material manufacturer shall warrant for a period of 30 years against Max 5 fade based on ASTM D2244 and Max 8 chalk based on ASTM D4212 and delamination of the paint finish.

1.6 PACKAGING, SHIPPING, AND HANDLING

A. Follow Manufacturer’s Recommendations.

B. Store material in accordance with Panel Manufacturer’s recommendations.

**PART 2 - PRODUCTS**

2.1 PANELS

A. Composite Panels

1. Panels shall be Reynobond® Fire Resistant (FR) Aluminum Composite Materials Reynobond® (ACM) as manufactured by Arconic Architectural Products LLC (AAP), 50

Industrial Boulevard, Eastman, Georgia 31023. Contact Eastman plant at 1-800-841-7774 or 478-374-4746 or at www.reynobond.com

2. Other manufacturers are acceptable as long as they meet the same criteria as Reynobond in thickness, panel weight, bond integrity, fire rating, paint color and finish. ACM must be manufactured in the USA.

B. Fire Resistant Core (FR)

C. Panel Thickness: RB160FR (4 mm) = 0.157" / RB240FR (6mm) = 0.236" (Editor Note: Select 4 mm or 6 mm)

D. Panel Weight: RB160FR (4 mm) = 1.53 lbs/sft / RB240FR (6 mm) = 2.0 lbs/sft (Editor Note: Select 4 mm or 6 mm)

E. Product Performance

1. Bond integrity: When tested for bond integrity, in accordance with ASTM D1781 (simulating resistance to panel delamination), there shall not be an adhesive failure of the bond a) between the core and the skin or b) cohesive failure of the core itself below the following values.
2. Peel Strength
   a. 100 N mm/mm (22.5 in lb./in.) As manufactured
   b. 100 N mm/mm (22.5 in lb./in.) After 21 days soaking in water at 70°F
3. Fire Performance: ASTM E84 – Passed Class A

F. Panel Finishes: Coil-coated Kynar 500® or Hylar 5000® based polyvinylidene fluoride (PVDF). AAP shall be Colorweld® 500 a fluoropolymer coating utilizing 70% Kynar 500® resins.
1. Color: To be chosen from AAP, Reynobond® standard series one, two or three colors.
2. Coating: Shall be factory applied on a continuous-process paint line. Coating shall consist of a 0.2 mil (approx.) prime coat and a 0.8 mil (approx.) finish coat containing 70% Kynar 500® resins. (If Colorweld® 500XL, coating shall consist of a 0.2 mil (approx.) barrier prime coat, a 0.80 mil (approx.) color coat, containing 70% Kynar 500® resins and a 0.5 mil (approx.) clear coat containing 70% Kynar 500® resins.) Nominal dry film thickness is 1.50 mils.
3. Gloss: ASTM D523 standard at 60º shall be 25–30.
4. Pencil hardness: ASTM D3363 shall be F-2H minimum.
5. Flexibility T-Bend: ASTM D4145 shall be 0-2T-Bend; no pick-off.
6. Adhesion: ASTM D3359 reverse impact 1/16" crosshatch shall show no cracking or adhesion loss.
7. Reverse Impact: ASTM D2794 1500 x metal thickness aluminum shall show no cracking or adhesion loss.
8. Acid Resistance: ASTM D1308, 10% muriatic acid, 24 hrs, shall show no effect. 20% sulfuric acid, 18 hrs, shall show no effect.
9. Acid Rain Test: Kesternich SO2, DIN 500180, 10 cycles min. No objectionable color change.
10. Alkali Resistance: ASTM D1308, 10%, 25% NaOH, 1 hr., shall show no effect.
11. Salt Spray Resistance: ASTM B117, 5% salt fog at 95°F. Pass 4,000 hrs. less than 1/16" average creep from scribe; up to a few #8 blisters.
12. Humidity Resistance: ASTM D714 & ASTM D2247 100% relative humidity at 95ºF, shall pass 4,000 hrs, # 8 blisters.

13. Exterior Exposure: 10 years at 45º, South Florida. ASTM D2244 shall be Max. 5 fade and ASTM D4214 shall be Max. 8 chalk.
14. Paint system shall meet the requirements of AAMA 2605 specifications.
15. (FEVE) Megaflon®, Coraflon®, Valflon® or any Lumiflon®-based paint systems are not acceptable.
16. 16. Paint system shall have more than 20 years of architectural field use.

2.2 PANEL FABRICATION

A. Fire Resistant ACM is comprised of two sheets of aluminum sandwiching a solid core of extruded thermoplastic material formed in a continuous process using no glues or adhesives between dissimilar materials. The core shall be free of voids and/or air spaces and not contain foamed insulation materials. The bond between the core and the skins shall be a chemical bond. Products laminated sheet by sheet in a batch process using glues or adhesives between materials shall not be acceptable.

B. Aluminum Face Sheets

1. Thickness: 0.020”
2. Aluminum alloy shall be 3000 series or equivalent.

C. Tolerances

1. Panel Bow: Shall not exceed 0.8% of panel overall dimension in width or length.
2. Panel Dimensions: Field fabrication shall be allowed where necessary, but shall be kept to an absolute minimum. All fabrication shall be done under controlled shop conditions when possible. Panel dimensions shall be such that there will be an allowance for field adjustment and thermal movement.
3. Panel Lines: Breaks and curves shall be sharp and true, and surfaces free of warps or buckles.
4. Flatness: Panels shall be visually flat.
5. Panel Surfaces: Shall be free of scratches or marks caused during fabrication.

D. System Characteristics

1. Plans, elevations, details, characteristics and other requirements indicated are based upon standards by one manufacturer. It is intended that other manufacturers, receiving prior approval, may be acceptable, provided their details and characteristics comply with size and profile requirements, and material/performance standards.
2. System must not generally have any visible fasteners, telegraphing or fastening on the panel faces or any other compromise of a neat and flat appearance (excludes face fastened solution)
3. Fabricate panel system to dimension, size and profile indicated on the drawings based on a design temperature of 68ºF (20ºC).
4. Fabricate panel system to avoid compressive skin stresses. The installation detailing shall be such that the panels remain flat regardless of temperature changes and at all times remain air- and watertight.
5. The finish side of the panel shall have a removable protective film applied prior to fabrication, which shall remain on the panel during fabrication, shipping and erection to protect the surface from damage.

E. System Type (select from the following)

1. Rout-and-Return Wet System: Fabricator and installer must provide an engineered system including clips, fasteners, anchors, spacers, trim, flashings, gaskets, sealant, etc.
2. Rout-and-Return Dry System: Fabricator and installer must provide an engineered pressure relief system including extruded perimeter frame; drainage gutter; all extrusions, clips, fasteners, anchors, spacers, trim, flashings, gaskets, sealant, etc.
3. Continuous Edge Grip System: Fabricator and installer must provide an engineered pressure relief system including extruded perimeter frame; drainage gutter; all extrusions, clips, fasteners, anchors, spacers, trim, flashings, gaskets, sealant, etc.
4. Face Fastened Solution: Fabricator and installer must provide an engineered system including fasteners, anchors, spacers, trim, and flashing. Fabricator and installer can purchase necessary extrusions, braces, fasteners, and necessary tools from manufacturer.

F. System Performance

1. Composite panels shall be capable of withstanding building movements and weather exposures based on the following test standards required by the architect and/or local building codes:
   a. Wind Load – If system tests are not available, under the direction of an independent third-party laboratory, mockups shall be constructed and tests performed to show compliance to the following minimum standards:
      1) Panels shall be designed to withstand the design wind load based upon the local building code, but in no case less than 20 pounds per square foot (psf) and 30 psf on parapet and corner panels. Wind-load testing shall be conducted in accordance with ASTM E330 to obtain the following results.
      2) Normal to the plane of the wall between supports, deflection of the secured perimeter-framing members shall not exceed L/175 or 3/4", whichever is less.
      3) Normal to the plane of the wall, the maximum panel deflection shall not exceed L/60 of the full span.
      4) Maximum anchor deflection shall not exceed 1/16". At 1 1/2 times design pressure, permanent deflections of framing members shall not exceedl/100 of span length and components shall not experience failure or gross permanent distortion. At connection points of framing members to anchors, permanent set shall not exceed 1/16".
   b. Air/Water System Test – Without backup waterproof membrane. If system tests are not available, under the direction of an independent third-party laboratory, mockups shall be constructed and tests performed to show compliance to the following minimum standards:
      1) Air Infiltration – When tested in accordance with ASTM E283, air infiltration at 1.57 psf must not exceed 0.06 cubic feet per minute per square foot of wall area.
      2) Water Infiltration – Water infiltration is defined as uncontrolled water leakage through the exterior face of the assembly. Systems not using a construction sealant at the panel joints (i.e., Dry Systems) shall be designed to drain any water leakage occurring at the joints. No water infiltration shall occur in any system under a differential static pressure of 6.24 psf after 15 minutes of exposure in accordance with ASTM E331.
   c. Fire Performance: Where required by governing code, provide fire retardant MCM that has been evaluated and is in compliance with code requirements specified

herein. Metal Construction Association Page www.arconicarchitecturalproducts.com

1) Fire Performance: Wall assemblies containing MCM System shall meet the requirements of the Intermediate Scale Multi-story test, NFPA 285, where required by code based for the design of this project.
2) The above tests are on panel systems that do not include a waterproof membrane behind panels.

2.3 ACCESSORIES

A. Extrusions, formed members, sheet and plate shall conform with ASTM B209 and the recommendations of the manufacturer.

B. Panel stiffeners, if required, shall be structurally fastened or restrained at the ends and shall be secured to the rear face of the composite panel with silicone of sufficient size and strength to maintain panel flatness. Stiffener material and/or finish shall be compatible with the silicone.

C. Sealants and gaskets within the panel system shall be as per manufacturer's standards to meet performance requirements.

D. Fabricate flashing materials from 0.040" minimum thickness aluminum sheet provided by panel manufacturer to match the adjacent curtain wall/panel system where exposed. Post-painted spray-applied flashings are not acceptable. Provide a lap strap under the flashing at abutted conditions and seal lapped surfaces with a full bead of non-hardening sealant.

E. Fasteners (concealed/non-corrosive): Fasteners as recommended by system fabricator and installer.

F. Weather barriers shall provide water penetration, water vapor transmission, and air penetration resistance according to the local requirements. Seal any holes in the weather barrier with manufacturer approved materials and methods.

**PART 3 - EXECUTION**

3.1 INSPECTION

A. Surfaces to receive panels shall be even, smooth, sound, clean, dry and free from defects detrimental to work. Notify contractor in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with erection until unsatisfactory conditions have been corrected.

B. Surfaces to receive panels shall be structurally sound as determined by a registered engineer.

3.2 INSTALLATION

A. Erect panels plumb and level.

B. Attachment system shall allow for the free vertical and horizontal thermal movement due to expansion and contraction for a material temperature range of -20ºF (-29ºC) to +180ºF (+82ºC). Buckling of panels, opening of joints, undue stress on fasteners, failure of sealants or any other detrimental effects due to thermal movement are not permitted. Fabrication, assembly and erection procedure shall account for the ambient temperature at the time of the respective operation.

C. Panels shall be erected in accordance with an approved set of shop drawings.

D. Anchor panels securely per engineering recommendations and in accordance with approved shop drawings to allow for necessary thermal movement and structural support.

E. Conform to panel fabricator's instructions for installation of concealed fasteners.

F. Do not install component parts that are observed to be defective, including warped, bowed, dented, scraped and broken members.

G. Do not cut, trim, weld or scrape component parts during erection in a manner that would damage the finish, decrease strength or result in a visual imperfection or a failure in performance. Return component parts that require alteration to shop for refabrication, or for replacement with new parts.

H. Separation dissimilar metals; use appropriate gaskets and fasteners to minimize corrosive or electrolytic action between metals.

3.3 ADJUSTING AND CLEANING

A. Remove and replace panels damaged beyond repair as a direct result of panel installation. After installation, panel repair and replacement shall become the responsibility of the general contractor.

B. Repair panels with minor damage.

C. Remove masking film (if used) as soon as possible after installation. Masking intentionally left in place after panel installation on an elevation shall become the responsibility of the general contractor.

D. Any additional protection, after installation, shall be the responsibility of the general contractor to remove.

E. Make sure weep holes and drainage channels are unobstructed and free of dirt and sealants.

F. Final cleaning shall not be part of the work of this section.

**END OF SECTION**

**SECTION 07 52 16**

**STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All roofing material removal and disposal work shall be performed in accordance with Section 07 01 50.19 “Preparation for Reroofing.”

### 1.2 SUMMARY

A. Section Includes:

1. Hybrid roofing system that combines built-up ply sheets with styrene-butadiene-styrene (SBS)-modified bituminous cap sheet.
2. Flashing sheets set in cold adhesive.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Cover board.
7. Walkways.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 06 16 00 "Sheathing" for wood-based, structural-use roof deck panels.
3. Section 07 21 00 "Thermal Insulation" for insulation beneath the roof deck.
4. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
5. Section 07 71 00 "Roof Specialties" for manufactured copings, gravel stops and roof edge flashings.
6. Section 07 92 00 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
7. Section 22 14 23 "Drainage Piping Specialties" for roof drains.

### 1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with the CHA's Designated Representative, Architect, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, interface with weather barrier, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Shop Drawings: Include plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation, including slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Saddles, and tapered edge strips, including slopes.
7. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
8. Tie-in with adjoining air barrier.

C. Samples for Verification: For the following products:

1. Cap Sheet: Samples of specified color.
2. Flashing Sheet: Samples of specified color.
3. Aggregate surfacing material in gradation and color required.
4. Walkway Pads or Rolls: Samples of specified color.

D. Wind Uplift Resistance Submittal: For roofing system indicating compliance with wind uplift performance requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer, and testing agency.

B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of complying with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Product Test Reports: For roof membrane and insulation, tests performed by a qualified testing agency, indicating compliance with specified requirements.

D. Evaluation Reports: For components of membrane roofing system, from ICC-ES.

E. Field Test Reports:

1. Concrete internal relative humidity test reports.
2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

F. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

C. Field Observer: Provide full time Registered Roof Observer (RRO) to observe the installation of the roofing system proceeds as specified. RRO shall provide daily reports to the Architect and the CHA’s Designated Representative.

D. Perform field adhesion testing of the reflective coating for each surface to be coated prior to installation. Provided letter from roofing manufacturer stating that proper adhesion was achieved.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

1. Protect stored liquid material from direct sunlight.
2. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.
2. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, vapor retarder, substrate board, roof pavers and other components of roofing system.

2. Manufacturer’s representative shall inspect and generate report at the following milestones:

a. Tear off.
b. Vapor barrier/retarder installation
c. Insulation installation

d. Cover board installation
e. Membrane installation
f. Walkways
g. Flashing installation
h. Coping installation
i. Payment requests

3. Warranty Period: 20 year – no dollar limit- from date of Substantial Completion.

B. Manufacture Inspection and Preventive Maintenance Requirement: By manufacturer's technical representative, to report maintenance responsibilities to the CHA necessary for preservation of the CHA's warranty rights. Inspections to occur in Years 2, 5, 10, and 15 following completion.

C. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, **[roof pavers], and [walkway products]**, for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

## PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

***A.*** General Performance: Installed roofing system and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight**..**

1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D 3746/D 3746M, ASTM D 4272/D 4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:

1. Zone 1 (Roof Area Field): 32.6 lbf/sq. ft.
2. Zone 2 (Roof Area Perimeter): 54.8 lbf/sq. ft..

a. Location: From roof edge to 7.7 feet from inside roof edge.

3. Zone 3 (Roof Area Corners): 82.4 lbf/sq. ft..

a. Location: 7.7 feet in each direction from each building corner.

D. FM Approvals' RoofNav Listing Roof membrane, base flashing, and component materials shall comply with requirements in FM Approvals 4450 or FM Approval 4470 as part of roofing system and shall be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify material with FM Approvals Certification markings.

1. Fire/Windstorm Classification Class 1A-90
2. Hail Resistance Rating: SH.

E. Energy Performance: Roofing system shall have an initial solar reflectance of not less than .9 and three year installed solar reflectance of not less than .88 when tested according to CRRC-1.

F. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency.

1. Identify products with appropriate markings of applicable testing agency.

## 2.2 MANUFACTURERS

A. Source Limitations: Obtain components for roofing system from a single roof membrane manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. Soprema, Inc.
c. Tremco Incorporated
d. Garland Roofing

2. Exposed Face Color: White

## 2.3 BASE SHEET MATERIALS

A. Asphalt-Coated Fiberglass Mat Base Sheet: ASTM D 4601/D 4601M, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; PermaPly 28
b. Soprema, Inc.: Modified Sopra G
c. Tremco Incorporated: BURmastic Composite Ply HT
d. Garland Roofing: HPR Premium Glasbase

2.4 INTERPLY SHEETS

A. Glass-Fiber Interply Sheet: ASTM D 2178/D 2178M, Type VI, Grade 1 asphalt-impregnated, glass-fiber felt.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville: GlasPly Premier.
b. Soprema, Inc.: Sopra-VI .
c. Tremco Incorporated: THERMglass Premium Type VI
d. Garland Roofing: HPR Premium Glasfelt

2.5 STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS CAP SHEET

A. Granule-Surfaced Roofing Cap Sheet: ASTM D 6162/D 6162M, Type III or IV, Grade G, SBS-modified asphalt sheet, reinforced with a combination of polyester and fiberglass fabric, suitable for cold adhesive or hot asphalt application method.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville: DynaMax FR CR G
b. Soprema, Inc.: Elastophene HS FR GR
c. Tremco Incorporated: POWERply 300 FR
d. Garland Roofing: Stressply Plus IV Plus Minerals

2. Granule Color: Ultra White or White with acrylic roof coating to meet Energy Performance requirements.

2.6 BASE FLASHING SHEET MATERIALS

A. Backer Sheet: ASTM D 6164/D 6164M, Type I or II, Grade S, SBS-modified asphalt sheet, reinforced with polyester fabric smooth surfaced, suitable for application method specified.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; DyanaBase PR
    b. Soprema, Inc.: SOPRALENE FLAM 180
    c. Tremco Incorporated: POWERply HE base sheet
    d. Garland Roofing: Stressbase 80 120

B. Granule-Surfaced Flashing Sheet: ASTM D 6162/D 6162M, Type I or II, Grade G, SBS-modified asphalt sheet, reinforced with a combination of polyester fabric and glass fibers, granule surfaced, suitable for application method specified, and as follows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville: DynaKap FR T1 HW CR G
    b. Soprema, Inc.: Elastophene HS FR GR
    c. Tremco Incorporated: Powerply premium FR
    d. Garland Roofing: Stressply IV/ IV Mineral

2. Granule Color: Ultra White or White with Acrylic Roofing Coating

## 2.7 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

C. Metal Termination Bars: Manufacturer's standard, pre-drilled stainless-steel, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

D. Cold-Applied Asphalt Adhesive: ASTM D 3019, Type III, roof membrane manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive, specially formulated for compatibility and use with **[roofing membrane] [and] [base flashings]**.

E. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

G. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

## 2.8 SUBSTRATE BOARDS

A. Substrate Board: ASTM C 1278/C 1278M, water-resistant, fiber-reinforced gypsum board.

1. Thickness: Type X, 5/8 inch (16 mm).
2. Surface finish**:** Factory primed.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. United States Gypsum Company; Securock Brand Gypsum Fiber Roof Board.
    b. GP, DensDeck Roof Board
    c. Approved equal.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

## 2.9 VAPOR RETARDER

A. Self-Adhering-Sheet Vapor Retarder: ASTM D 1970/D 1970M polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil- (1.0-mm-) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

## 2.10 ROOF INSULATION

A. General: Preformed roof insulation boards, manufactured or approved by roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roofing system identical to that used for this Project.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Atlas Roofing Corporation; ACFoam.
    b. CertainTeed Corporation; FlintBoard
    c. Hunter Panels; H-Shield.
    d. Johns Manville; Energy-3.
    e. Soprema, Inc.; Sopra-ISO
    f. Tremco; Trisotech Insulation.

2. Compressive Strength: 20 psi (138 kPa).
3. Size: 48 by 96 inches (1219 by 2438 mm).
4. Thickness:

    a. Base Layer: 1-1/2 inches (38 mm).
    b. Upper Layer: To achieve minimum R-30 value, or as indicated on Drawings.

C. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Slope:

a. Roof Field: as indicated on Drawings.
b. Saddles and Crickets: as indicated on Drawings.

## 2.11 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation [ and cover boards] to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
1. Full-spread spray-applied, low-rise, two-component urethane adhesive.

D. Insulation Cant Strips: ASTM C 728, perlite insulation board.

E. Tapered Edge Strips: ASTM C 728, perlite insulation board.

F. Cover Board: ASTM C 1278/C 1278M, fiber-reinforced gypsum board.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. United States Gypsum Company; Securock Brand Gypsum Fiber Roof Board.
b. GP, DensDeck Roof Board
c. Approved Equal

2. Thickness: Type X, 5/8 inch.
3. Surface Finish: Factory primed.

## 2.12 ASPHALT MATERIALS

A. Asphalt Primer: ASTM D 41/D 41M.

B. Roofing Asphalt: ASTM D 312/D 312M, Type III or IV as recommended by roofing system manufacturer for application.

## 2.13 WALKWAYS

A. Walkway Pads: Reinforced asphaltic composition pads with slip-resisting mineral-granule surface manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 3/8 inch thick, minimum.

1. Pad Size: Approximately 36 by 60 inches
2. Color: Contrasting with cap sheet.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 05 31 00 "Steel Decking."

4. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested according to ASTM F 2170.

a. Test Frequency: One test probe per each 1000 sq. ft. (93 s2. m)of roof deck, with not less than three test probes.
b. Submit test reports within 24 hours of performing tests.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions.

1. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction.

1. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. and allow primer to dry.

## 3.3 ROOFING INSTALLATION, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast.

1. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.

D. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

## 3.4 SUBSTRATE BOARD INSTALLATION

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.

1. Tightly butt substrate boards together.
2. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
3. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' RoofNav and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

## 3.5 VAPOR RETARDER INSTALLATION

A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
2. Seal laps by rolling.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSULATION INSTALLATION

A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing system with vertical surfaces or angle changes greater than 45 deg F.

1. Install upper layers of insulation and tapered insulation, with joints of each layer offset not less than 12 inches from previous layer of insulation.

    a. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
    b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    c. Make joints between adjacent insulation boards not more than 1/4 inch in width.

d. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus 24 inches.
e. Trim insulation, so that water flow is unrestricted.
f. Fill gaps exceeding 1/4 inch with insulation.
g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
h. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:

1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

D. Installation Over Lightweight Insulating Concrete Decks:

1. Mechanically fasten vented base sheet to lightweight insulating concrete roof deck, with vented side down, using mechanical fasteners specifically designed and sized for fastening to lightweight insulating concrete decks.

a. Fasten vented base sheet to resist uplift pressure at corners, perimeter, and field of roof.

2. Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows.

a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
d. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus 24 inches.

1) Trim insulation, so that water flow is unrestricted.

e. Fill gaps exceeding 1/4 inch with insulation.

f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
g. Adhere base layer of insulation to vented base sheet according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:

1) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3. Install upper layers of insulation and tapered insulation, with joints of each layer offset not less than 12 inches from previous layer of insulation.

a. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
d. At internal roof drains, slope insulation to create a square drain sump, with each side equal to the diameter of the drain bowl plus 24 inches.

1) Trim insulation, so that water flow is unrestricted.

e. Fill gaps exceeding 1/4 inch with insulation.
f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
g. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:

1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

## 3.7 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines, with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

a. Trim cover board, so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:

a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

B. Install sheathing paper over cover board and immediately beneath roof membrane.

3.8 ROOFING MEMBRANE INSTALLATION, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

C. Where roof slope exceeds 1/2 inch per 12 inches **(**1:24**)**, install roofing membrane sheets parallel with slope.

1. Backnail roofing sheets to nailer strips according to roofing system manufacturer's written instructions.

D. Coordinate installation of roofing system so insulation and other components of the roofing system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.
2. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.9 BASE SHEET INSTALLATION

A. Before installing, unroll base sheet, cut into workable lengths, and allow to lie flat for a time period recommended by manufacturer for the ambient temperature.

B. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of 2 inches and 6 inches, respectively.

C. Installation of SBS-Modified Bitumen Polyester and Fiberglass-Mat Base Sheet:

1. Install base sheet according to roofing manufacturer's written instructions, starting at low point of roofing system.
2. Extend roofing sheets over and terminate above cants.
3. Install base sheet in a shingle fashion.
4. Adhere to substrate in a uniform coating of cold-applied adhesive.

5. Install base sheet without wrinkles, rears, and free from air pockets.
6. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps.

a. Lap side laps as recommended by roof membrane manufacturer but not less than 3 inches.

b. Lap end laps as recommended by roof membrane manufacturer but not less than 12 inches.
c. Stagger end laps not less than 18 inches.
d. **[Heat weld end laps,] [Completely bond and seal laps,]** leaving no voids.
e. Roll laps with a 20-pound roller.

7. Repair tears and voids in laps and lapped seams not completely sealed.
8. Apply pressure to the body of the base sheet according to manufacturer's instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

## 3.10 INSTALLATION OF INTERPLAY SHEETS

A. Install one ply sheets, starting at low point of roofing.

1. Align ply sheets without stretching.
2. Shingle side laps of ply sheets uniformly to achieve required number of plies throughout thickness of roofing membrane.

a. Shingle in direction to shed water.

3. Extend ply sheets over and terminate above cants.

## 3.11 SBS-MODIFIED BITUMINOUS CAP SHEET INSTALLATION

A. Before installing, unroll cap sheet, cut into workable lengths, and allow to lie flat for a time period recommended by manufacturer for the ambient temperature at which cap sheet will be installed.

B. Install modified bituminous roofing cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system.

1. Extend cap sheet over and terminate above cants.
2. Install cap sheet in a shingle fashion.
3. Install cap sheet as follows:
    a. Adhere to substrate in cold-applied adhesive.

4. Install cap sheet without wrinkles or tears, and free from air pockets.
5. Install cap sheet, so side and end laps shed water.

C. Laps: Accurately align roofing sheets, without stretching, and maintain uniform side and end laps.

1. Lap side laps as recommended by roof membrane manufacturer but not less than 3 inches.
2. Lap end laps as recommended by roof membrane manufacturer but not less than 12 inches.
3. Stagger end laps not less than 18 inches.
4. Heat weld laps, leaving no voids.
5. Roll laps with a 20-pound roller.
6. Repair tears and voids in laps and lapped seams not completely sealed.

D. Apply pressure to the body of the cap sheet according to manufacturer's instructions, to remove air pockets and to result in complete adhesion of base sheet to substrate.

## 3.12 FLASHING AND STRIPPING INSTALLATION

A. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof, and secure to substrates according to roofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by roofing system manufacturer.
2. Backer Sheet Application:

    a. Mechanically fasten backer sheet to walls or parapets.
    b. Adhere backer sheet over roofing membrane at cants in cold-applied adhesive.
    c. Seal all laps.

3. Backer Sheet Application:

    a. Adhere backer sheet to substrate in cold-applied adhesive.
    b. Seal all laps.

4. Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.

B. Extend base flashing up walls or parapets a minimum of 12 inches above roofing membrane and 12 inches onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

D. Install liquid flashing system according to manufacturer's recommendations.

1. Extend liquid flashing not less than 3 inches (76 mm) in all directions from edges of item being flashed.
2. Embed granules, matching color of roof membrane, into wet compound.

E. Roof Drains: Set 30-by-30-inch- 4-pound lead flashing in bed of asphaltic adhesive on completed roofing membrane.

1. Cover lead flashing with roofing cap-sheet stripping, and extend a minimum of 6 inches beyond edge of metal flashing onto field of roofing membrane.
2. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
3. Install stripping according to roofing system manufacturer's written instructions.

## 3.13 WALKWAY INSTALLATION

A. Walkway Pads: Install walkway pads using units of size indicated or, if not indicated, of manufacturer's standard size, according to walkway pad manufacturer's written instructions.

1. Install walkways at the following locations:

a. Perimeter of each rooftop unit.
b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
d. Top and bottom of each roof access ladder.
e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
f. Locations indicated on Drawings.
g. As required by roof membrane manufacturer's warranty requirements.

2. Provide 3-inch (76-mm) clearance between adjoining pads.

3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.14 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

1. Notify Architect and the CHA's Designated Representative 48 hours in advance of date and time of inspection.

B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

C. Roofing system will be considered defective if it does not pass tests and inspections.

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.15 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the CHA's Designated Representative.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.16 ROOFING INSTALLER'S WARRANTY

A. WHEREAS_____of_____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: **C**hicago Housing Authority (CHA).
2. Address: <**Insert address**>.
3. Building Name/Type: <**Insert information**>.
4. Address: <**Insert address**>.
5. Area of Work: <**Insert information**>.
6. Acceptance Date:_____.
7. Warranty Period: <**Insert time**>.
8. Expiration Date:_____.

B. AND WHEREAS Roofing Installer has contracted (either directly with the CHA or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This 20 years NDL Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed exceeding 100 (m/s);
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by the CHA.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by the CHA or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if the CHA allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the CHA engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified the CHA in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. The CHA shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off the CHA from other remedies and resources lawfully available to the CHA in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with the CHA or a subcontract with the CHA's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this_____day of _____,_____.

1. Authorized Signature:_____.
2. Name:_____.
3. Title:_____.

**END OF SECTION**

**SECTION 07 62 00**

**SHEET METAL FLASHING AND TRIM**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Manufactured reglets with counterflashing.
2. Formed roof-drainage sheet metal fabrications.
3. Formed low-slope roof sheet metal fabrications.
4. Formed steep-slope roof sheet metal fabrications.
5. Formed wall sheet metal fabrications.
6. Formed equipment support flashing.
7. Formed overhead-piping safety pans.

B. Related Requirements:

1. Section 06 10 00 “Rough Carpentry" for wood nailers, curbs, and blocking.

### 1.3 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following

1. Underlayment materials.
2. Elastomeric sealant.
3. Butyl sealant.
4. Epoxy seam sealer.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.

C. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

D. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested **[and] [FM Approvals approved]**.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

D. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested [**and**] [**FM Approvals approved**], shop shall be listed as able to fabricate required details as tested and approved.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical roof edge, including fascia, approximately 3 feet long, including supporting construction cleats, seams, attachments, underlayment and accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the CHA specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta units when tested in accordance with ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period:20 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install copings and roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

    1. Design Pressure: As defined by applicable local building code.

D. FM Approvals Listing: Manufacture and install copings and roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with name of fabricator and design approved by FM Approvals.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

    1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Materials: Use same materials for replacement as existing materials. Furnish one of the following

1. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.

a. Factory Prime Coating: Where painting after installation is required, pretreat metal with white or light-colored, factory-applied, baked-on epoxy primer coat; minimum dry film thickness of 0.2 mil (0.005 mm).

2. Stainless Steel Sheet: ASTM A 167; Type 304, dead soft, fully annealed; with No 2D finish, except where harder temper is required for forming or performance.
3. Zinc Coated (Galvanized) Steel sheet: ASTM A 653/A 653, G90 (Z275) coating designation; structural quality.

## 2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

B. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 40 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlisle; CCW WIP 300HT.
b. GCP Applied Technologies Inc; Grace Ice and Water Shield HT.
c. Henry Company; Blueskin PE200HT.

2. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F (29 deg C) or lower.
3. Thermal Stability; ASTM D 1970, Stable after testing at 240 deg F or higher.

## 2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners [**solder**], protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal [**or manufactured item**] unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal [**or manufactured item**].

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

C. Solder:
1. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

G. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

H. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Cheney Flashing Company.
    b. Fry Reglet Corporation.
    c. Heckmann Building Products, Inc.
    d. Hickman Company, W. P.
    e. Hohmann & Barnard, Inc.
    f. Keystone Flashing Company, Inc.
    g. National Sheet Metal Systems, Inc.
    h. Sandell Manufacturing Co., Inc.
2. Source Limitations: Obtain reglets from single source from single manufacturer.
3. Material**: [Stainless steel, 0.019 inch (0.48 mm) thick] Aluminum, 0.024 inch (0.61 mm) thick] [Galvanized steel, 0.022 inch (0.56 mm) thick]**.

4. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
5. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
6. Accessories:

    a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
    b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

7. Finish: With manufacturer's standard color coating.

## 2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams:
1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

## 2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters:

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate in minimum 96-inch- (2400-mm-) long sections.
3. Furnish flat-stock gutter brackets and **[flat-stock] [twisted]** gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than **[twice the gutter thickness] [dimension indicated on Drawings]**.
4. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
5. Gutter Profile: Style K in accordance with cited sheet metal standard.
6. Expansion Joints: Butt type with cover plate.
7. Accessories: Wire-ball downspout strainer and flat ends.

8. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following materials:

   a. Copper: 16 oz./sq. ft. (0.55 mm) thick.
   b. Aluminum: 0.032 inch (0.81 mm) thick.

B. Downspouts: Fabricate **[round] [rectangular]** downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.

C. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape required, complete with outlet tubes[, exterior flange trim,] [and] [built-in overflows]. Fabricate from the following materials:

1. Aluminum: [0.032 inch (0.81 mm)]

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch-(2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates. Shop fabricate interior and exterior corners.

1. Joint Style: Overlapped, 4 inches (100 mm) wide
2. Fabricate from the following materials:

a. Aluminum: 0.050 inch (1.27 mm).

B. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, solder or weld watertight. Shop fabricate interior and exterior corners.

1. Coping Profile: To match existing.
2. Joint Style: Butted with expansion space and 6-inch- (150-mm-) wide, exposed cover plate.

3. Fabricate from the following materials:

   a. Aluminum: 0.050 inch (1.27 mm)

C. Expansion-Joint Cover: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Aluminum: 0.050 inch (1.27 mm).

D. Base Flashing: Fabricate from the following materials:

1. Aluminum: 0.040 inch (1.02 mm)
2. Stainless Steel: 0.019 inch (0.48 mm)
3. Galvanized Steel: 0.028 inch (0.71 mm)

E. Counterflashing: Fabricate from the following materials:

1. Aluminum: 0.032 inch (0.81 mm)
2. Stainless Steel: 0.019 inch (0.48 mm)
3. Galvanized Steel: 0.022 inch (0.56 mm)

F. Flashing Receivers: Fabricate from the following materials:

1. Aluminum: 0.032 inch (0.81 mm)
2. Stainless Steel: 0.016 inch (0.40 mm)
3. Galvanized Steel: 0.022 inch (0.56 mm)

G. Roof-Penetration Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.019 inch (0.48 mm)
2. Galvanized Steel: 0.028 inch (0.71 mm)

H. Roof-Drain Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.016 inch (0.40 mm)

## 2.8 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings; and form with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:

1. Stainless Steel: 0.016 inch (0.40 mm)

B. Wall Expansion-Joint Cover: Fabricate from the following materials:

1. Aluminum: 0.040 inch (1.02 mm)
2. Stainless Steel: 0.019 inch (0.48 mm)

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.019 inch (0.48 mm)
2. Galvanized Steel: 0.028 inch (0.71 mm)

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, andsecurely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.

4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses.
5. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

## 3.3 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds and sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches (300 mm) o.c.
6. Space individual cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws, or substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).

2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pretin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pretinning where pretinned surface would show in completed Work.
2. Do not solder metallic-coated steel and aluminum sheet.
3. Do not use torches for soldering.
4. Heat surfaces to receive solder, and flow solder into joint.

a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

5. Stainless Steel Soldering:

a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
b. Promptly remove acid-flux residue from metal after tinning and soldering.
c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

6. Copper Soldering: Tin edges of uncoated sheets, using solder for copper.

H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

## 3.4 INSTALLATION OF ROOF-DRAINAGE SYSTEM

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:

1. Join sections with **[riveted and soldered joints]**
2. Provide for thermal expansion.

3. Attach gutters at eave or fascia to firmly anchor them in position.
4. Provide end closures and seal watertight with sealant.
5. Slope to downspouts.
6. Fasten gutter spacers to front and back of gutter.
7. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
8. Anchor gutter with gutter brackets spaced not more than 24 inches (600 mm) apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
9. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 feet (15.2 m) apart. Install expansion-joint caps.

C. Downspouts:

1. Join sections with 1-1/2-inch (38-mm) telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c.
4. Provide elbows at base of downspout to direct water away from building.

D. Conductor Heads: Anchor securely to wall, with elevation of conductor head rim at minimum of 1 inch (25 mm) below **[scupper] [or] [gutter]** discharge.

E. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of 4 inches (100 mm) in direction of water flow.

## 3.5 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch (75-mm) centers.

3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Copings:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.

   a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at manufacturer's required spacing that meets performance requirements.
   b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at manufacturer's required spacing that meets performance requirements.

3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches (100 mm) over base flashing.
3. Lap counterflashing joints minimum of 4 inches (100 mm).
4. Secure in waterproof manner by means of **[snap-in installation and lead wedges and sealant] [anchor and washer spaced at 12 inches (300 mm) o.c. along perimeter and 6 inches (150 mm) o.c. at corners areas]** unless otherwise indicated.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with **[elastomeric] [butyl]** sealant acceptable to the roofing manufacturer and clamp flashing to pipes that penetrate roof.

## 3.6 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

C. Reglets: Installation of reglets is specified in Section 04 20 00 "Unit Masonry."

## 3.7 INSTALLATION OF MISCELLANEOUS FLASHING

A. Equipment Support Flashing:

1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
2. Weld or seal flashing with elastomeric sealant to equipment support member.

B. Overhead-Piping Safety Pans:

1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
2. Pipe and install drain line to plumbing waste or drainage system.

## 3.8 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

## 3.9 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

## 3.10 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

**END OF SECTION**

**SECTION 07 71 00**

**ROOF SPECIALTIES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Copings.
2. Roof-edge specialties.
3. Roof-edge drainage systems.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for downspout guards and downspout boots.
2. Section 06 10 00 "Rough Carpentry" for wood nailers, curbs, and blocking.
3. Section 07 62 00 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
4. Section 07 72 00 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
5. Section 07 92 00 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

C. Preinstallation Conference: Conduct conference at Project site.

1. Meet with the CHA's Designated Representative, Architect, roofing Installer, roofing-system manufacturer's representative, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties.

1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
4. Detail termination points and assemblies, including fixed points.
5. Include details of special conditions.

C. Samples for Verification:

1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.
2. Include copings, roof-edge specialties, and roof-edge drainage systems made from 12-inch lengths of full-size components in specified material, and including fasteners, cover joints, accessories, and attachments.

## 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of roof specialty.

C. Product Test Reports: For copings and roof-edge flashings, for tests performed by a qualified testing agency.

D. Sample Warranty: For manufacturer's special warranty.

## 1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing specialties to include in maintenance manuals.

## 1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are SPRI ES-1 tested to specified design pressure **and FM Approvals listed for specified class**.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and set quality standards for fabrication and installation.

1. Build mockup of typical roof edge, including fascia, gutter, and downspout, approximately 5 feet long, including supporting construction, seams, attachments, underlayment, and accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.

B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. FM Approvals' Listing: Manufacture and install copings and roof-edge specialties that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with FM Approvals' markings.

C. SPRI Wind Design Standard: Manufacture and install copings and roof-edge specialties tested according to SPRI ES-1 and capable of resisting the following design pressures:

1. Design Pressure: As defined by applicable local building code.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 2.2 COPINGS

A. Metal Copings: Manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; with corner units, end cap units, and concealed splice plates with finish matching coping caps.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Architectural Products Company.
b. Merchant and Evans.
c. Metal-Era, Inc.
d. OMG, Inc.
e. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.

2. Formed Aluminum Sheet Coping Caps: Aluminum sheet, 0.050 inch (1.27 mm) thick.

a. Surface: Smooth, flat finish.
b. Finish: Two-coat fluoropolymer
c. Color: As selected by Architect from manufacturer's full range.

3. Corners: Factory mitered and continuously welded.
4. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.

a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches (300 mm) wide, with integral cleats.

## 2.3 ROOF-EDGE SPECIALTIES

A. One-Piece Gravel Stops: Manufactured, one-piece, metal gravel stop in section lengths not exceeding 12 feet (3.6 m), with a horizontal flange and vertical leg fascia terminating in a drip edge, and concealed splice plates of same material, finish, and shape as gravel stop. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Architectural Products Company.
b. Metal-Era, Inc.
c. OMG, Inc.
d. PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.

2. Formed Aluminum Sheet Gravel Stops: Aluminum sheet, 0.050 inch (1.27 mm) thick.

a. Surface: Smooth, flat finish.
b. Finish: Two-coat fluoropolymer.
c. Color: As selected by Architect from manufacturer's full range.

3. Corners: Factory mitered and continuously welded.
4. Accessories:
a. Fascia extenders with continuous hold-down cleats

## 2.4 ROOF-EDGE DRAINAGE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Architectural Products Company.
2. Merchant and Evans.
3. Metal-Era, Inc.
4. OMG, Inc.

B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Aluminum Sheet: 0.050 inch (1.27 mm) thick.
2. Gutter Profile: As indicated on Drawings according to SMACNA's "Architectural Sheet Metal Manual."
3. Corners: Factory mitered and continuously welded.
4. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters.
5. Gutter Accessories: Wire ball downspout strainer and flat ends.

C. Downspouts: **Plain rectangular** complete with smooth-curve elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Formed Aluminum: 0.040 inch (1.02 mm) thick.

D. Aluminum Finish: Two-coat fluoropolymer

1. Color: As selected by Architect from manufacturer's full range.

## 2.5 MATERIALS

A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

## 2.6 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carlisle Coatings & Waterproofing Inc.
    b. GCP Applied Technologies Inc.
    c. Henry Company.
    d. Owens Corning.

2. Thermal Stability: ASTM D 1970/D 1970M; stable after testing at 240 deg F (116 deg C).
3. Low-Temperature Flexibility: ASTM D 1970/D 1970M; passes after testing at minus 20 deg F (29 deg C).

B. Slip Sheet: Rosin-sized building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum.

## 2.7 MISCELLANEOUS MATERIALS

A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.

B. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

C. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

D. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

## 2.8 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Coil-Coated Aluminum Sheet Finishes:

1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
b. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

1. Apply continuously under copings and roof-edge specialties.
2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.

## 3.3 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 feet, with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.

E. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

## 3.4 COPING INSTALLATION

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

## 3.5 ROOF-EDGE SPECIALITIES INSTALLATION

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

## 3.6 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion-joint caps.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.

1. Provide elbows at base of downspouts at grade to direct water away from building.

## 3.7 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

**END OF SECTION**

**SECTION 07 72 00**

**ROOF ACCESSORIES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Roof curbs.
2. Roof hatches.
3. Pipe portals.
4. Cell phone equipment supports.
5. Fall protection / Roof davits

B. Related Sections:

1. Section 05 50 00 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 07 62 00 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
3. Section 07 71 00 "Roof Specialties" for manufactured fascia, copings, gravel stops, gutters and downspouts.
4. Section 23 05 48 "Vibration Controls for HVAC" for special curbs designed to accommodate seismic and vibration controls.
5. Section 23 34 23 "HVAC Power Ventilators" for power roof-mounted ventilators.

### 1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.2 ROOF CURBS

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded

or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Custom Curb Inc.
    b. Pate Company (The).
    c. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Comply with loading and strength requirements as indicated where units support other work.

D. Material: Aluminum sheet, 0.090 inch (2.28 mm) thick.

1. Finish: Mill

E. Construction:

1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
3. Top Surface: Level top of curb.
4. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
5. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
6. Liner: Same material as curb, of manufacturer's standard thickness and finish.
7. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
8. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

## 2.3 ROOF HATCH

A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BILCO Company (The).
    b. Dur-Red Products.
    c. Wasco Products, Inc.

B. Type and Size: Single-leaf lid, 30 by 36 inches (750 by 900 mm) for ladder access, uncles otherwise indicated on Drawings.

C. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.

D. Hatch Material: Aluminum sheet.

1. Thickness: 11 gauge.
2. Finish: Mill.

E. Construction:

1. Insulation: Polyisocyanurate board.
2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
5. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.

F. Hardware: Spring operators, hold-open arm, galvanized-steel spring latch with turn handles, galvanized-steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

1. Height: 42 inches above finished roof deck.
2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches (31 mm) in diameter or galvanized-steel tube, 1-5/8 inches (41 mm) in diameter.
3. Flat Bar: Galvanized steel, 2 inches (50 mm) high by 3/8 inch (9 mm) thick.
4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches (533 mm) in diameter.
5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
6. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
7. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
8. Fabricate joints exposed to weather to be watertight.
9. Fasteners: Manufacturer's standard, finished to match railing system.
10. Finish: Manufacturer's standard.

a. Color: As selected by Architect from manufacturer's full range.

H. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.

1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
2. Height: 42 inches above finished roof deck.

## 2.4 METAL MATERIALS

A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill Finish: As manufactured.

B. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

C. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.

D. Steel Tube: ASTM A 500/A 500M, round tube.

E. Galvanized-Steel Tube: ASTM A 500/A 500M, round tube, hot-dip galvanized according to ASTM A 123/A 123M.

F. Steel Pipe: ASTM A 53/A 53M, galvanized.

## 2.5 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C 1289, thickness and thermal resistivity as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium**,** and complying with AWPA C2; not less than 1-1/2 inches thick.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

E. Underlayment:

1. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
3. Slip Sheet: Building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum, rosin sized.
4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

5. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
6. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
7. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

G. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

H. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

I. Asphalt Roofing Cement: ASTM D 4586/D 4586M, asbestos free, of consistency required for application.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.

2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof Curb Installation: Install each roof curb so top surface is level.

D. Roof-Hatch Installation:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post according to manufacturer's written instructions.

E. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

## 3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 13 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

**END OF SECTION**

**SECTION 07 76 00**

**ROOF PAVERS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Furnish and install a complete Architectural Pavers and Adjustable Pedestals deck support system with a maximum cavity height of up to 22 inches.

B. Related Sections include the following:

1. Division 02 - Section 02780 Unit Pavers.
2. Division 03 - Section 03300 Cast-in-Place Concrete.
3. Division 06 - Section 06100 Rough Carpentry.
4. Division 07 - Section 07760 Roof Pavers.
5. Division 07 - Section 07620 Roof related Metal Work.
6. Division 07 - Section 07540 Fluid Applied Waterproofing.
7. Division 07 - Section 07540 Bituminous Sheet Waterproofing.
8. Division 07 - Section 07760 Roof Pavers.

### 1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D 638 - Tensile Properties of Plastics
2. ASTM D 790 - Flexural Properties of Unreinforced and Reinforced Plastics Insulating
3. ASTM D 1525 -Vicat Softening Temperature of Plastics

### 1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Samples:

1. Architectural Pavers: Submit samples for type, color and texture required.
2. Pedestals: Submit sample of each pedestal component.
3. PVC Pipe: Submit 12-inch long sample of PVC pipe.

C. Shop Drawings: Submitted by contractor showing all components required for the paver & pedestal requirements. Shop drawings shall include plan drawings showing layout of all paver areas and detail drawings showing how the various components of the system fit together. Include manufacturer's literature completely describing all components of the paver pedestal systems and giving detailed installation recommendations and instructions. Also included detailed installation drawings for all precast pavers.

1.5 QUALITY ASSURANCE

A. **Manufacturer Qualifications:** All products covered under this Section shall be produced by a single manufacturer unless otherwise specified with a minimum of fifteen (15) years proven production experience.

B. **Installer Qualifications:** Installer shall have a minimum of three (3) years proven construction experience and be capable of estimating & building from blueprint plans and details, determining elevations, in addition to proper material handling. All Work must comply with Tile Tech Inc installation application procedures for pedestal mounted pavers as specified herein.

C. **Special Consideration:** The installer and or subcontractor must assume the responsibility for and take into consideration (1) the structural capability and adequacy of the structure to carry the dead and live load weight(s) involved, and (2) that the density of any insulation is satisfactory to resist crushing and damaging the waterproofing membrane.

1.6 DELIVERY, STORAGE, AND HANDLING

A. In accordance with provisions of Section 01300.

B. Protect Concrete Pavers and Pedestal System during shipment, storage and construction against damage. Store a minimum of 4 inches off the ground in a dry location and cover with polyethylene to protect from contact with materials which would cause staining or discoloration.

1.7 PROJECT CONDITIONS

A. Tile Tech Pedestal System specified are to be used with pedestrian traffic only & all four (4) sides of a deck system must restrain and contain the decking panels with perimeter blocking or walls. Decking panels must not be allowed to move laterally.

B. All membrane waterproofing and protection board surfaces to receive pedestals must be broom clean, frost free, and free of dirt, oil or any rough foreign matter, which may impair the waterproofing / roofing manufacturers guarantee or protection requirements.

C. The substrate that is to receive pedestals must have slope and provide positive and adequate drainage in accordance with good building practice and applicable building codes.

**D. Decks over Roofing and Waterproofing;**

1. If high density closed cell extruded 60psi polystyrene insulation is installed on top of the membrane in a protected membrane system, Tile Tech Pedestals may be installed directly on top of this type of insulation.
2. Do not use Tile Tech Pedestals over any insulation less than 60psi or with low density polystyrene (bead board) insulation.

E. Installation or anticipated installation of additional items on top of the deck such as planters, hot tubs, sculptures, or industrial equipment must be supported directly by additional pedestals that are in addition to the main deck paver/tile pedestal system. Failure to adequately support the additional weight of any such features or items may cause significant damage to the deck, underlying structure, or waterproofing .

1.8 WARRANTIES / GUARANTEES

A. Tile Tech Pedestal System (pavers and pedestals) shall remain free from defects for a period of ten (10) years. The contractor shall warrant that his work will remain free from defects of labor and materials used in conjunction with his work in accordance with the general conditions for this project or a maximum of three (3) years.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The Paver Pedestal Systems specified herein are based upon products manufactured by:
**Tile Tech Inc.**, 888-380-5575 Phone: (213) 380-5560 Fax: (213) 380-5561
E-mail: sales@tiletechpavers.com Website: www.tiletechpavers.com

B. Paver Pedestal Systems equal in appearance and function and meeting these specifications, will be acceptable when the specified submittals are approved in writing by the Architect prior to bid.

2.2 MATERIALS

A. CONCRETE PAVERS:

1. Type: Cool-Roof™
2. Colors: “Cool-White” and “Cool-Gray”
3. Sizes: 12”x24” and 16”x24”
4. Finish: Shot-blasted with 3/16” bevel on all four (4) sides of finished surface.

B. PEDESTALS:

1. Stak-Cap™ Pedestals: PVC Pipe & Stack Adjustable

a. Stack or use SDR35 PVC pipe to accommodate various HEIGHT adjustments of ½" to 2".
b. Each cap provides maximum of ½" of HEIGHT and 1% SLOPE. Rotate and stack one cap relative to another to accommodate SLOPE adjustments from 0% to 5%.
c. Base diameter of 6-inch and top diameter of 5-¼-inch and is ½-inch high.
d. Made of high impact and flame resistant ABS plastic.
e. Use of Buffer Pads under Stak-Cap™ Pedestals is MANDATORY.

2. Uni-Shims™: 1/8-inch & 1/16-inch Thick
a. Can be used whole or broken into halves or quarters and can be stacked up to 2 high.
b. Used on top or under Stak-Cap™ or Uni-Just™ Pedestals for fine leveling of pedestals and or individual pavers.
c. Made of high impact and flame resistant ABS plastic.

C. OTHER COMPONENTS: INSTALLER OR USER SUPPLIED

1. Pedestal Pipe: 4-inch diameter SDR35 PVC Sewer Pipe

a. Used with either Stak-Cap™ or Uni-Just™ Pedestals and is cut to required height.
b. Dimensions: 4.215-inch outside diameter & 3.890-inch inside diameter.
c. Meet ASTM D-3034 and F-679.
d. NOT supplied with pedestal components by Tile Tech Inc.

2. Protection Course:

a. Protection board (required over insulated BUR systems, and when specified for use over bituminous asphalt-based waterproofing): W.R. Meadows "Vibraflex" or equal, minimum 3/8- inch thick asphaltic composition protection board.
b. Insulation (when specified): Dow Styrofoam "Highload 100" or equal, minimum compressive strength of 100psi recommended for foam plastic insulation placed beneath Pedestal System to prevent damage to the waterproofing membrane.
c. NOT supplied with pedestal components by Tile Tech Inc.

2.3 PERIMETER CONTAINMENT AND SUPPORT

A. The complete assembly of insulation (if used), protection board (if used), drainage mat (if used), pedestals and pavers must be restrained at the perimeter of the deck area.

B. Perimeter parapet walls, concrete dividers or other perimeter restraint must be capable of resisting lateral forces (including seismic and wind). Cumulative movement in excess of 1/8 inch will void the Tile Tech Inc Pedestal System warranty.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Prior to starting work inspect the substrate to ensure that it has been properly prepared to accept the Tile Tech Pedestal System. The substrate and or surface shall be clean and free of any projections and debris which may impair the performance of the pedestal and or the deck system. Verify all elevations, required pedestal heights and deck dimensions. Commencement of work shall imply acceptance of surfaces & deck conditions.

B. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

3.2 PREPARATION

A. The substrate surface that will receive the Pedestal System must be well compacted (on Grade) or structurally capable of carrying the dead and live loads anticipated.

1. Insulation OVER the membrane: (Option 1) Insulation and/or protection board (if specified) must be applied over the waterproofing substrate and/or specified drainage mat. Install the system according to the membrane manufacturer's recommendations and specifications.
2. Insulation UNDER membrane: (Option 2) Insulation required to be installed within a roofing system below deck supports must meet the roofing membrane manufacturers' specifications and must have a minimum core density of 60psi.
3. Protection Board: (for asphalt type systems used over waterproofing) Full coverage 1/8-inch asphaltic composition protection board is recommended. When protection is specified only under the pedestal cut protection board pads to extend beyond the outside perimeter of the pedestal system base or buffer pad by a minimum of TWO (2) inch.
4. Drainage Mat: (when desired or specified) Install drainage mat according to the manufacturers recommendations to avoid crushing.

3.3 INSTALLATION

A. Install in accordance with Tile Tech Inc. and other contributing manufacturer's instructions. Installation requirements vary for each individual project site. Decking paver or tile used, pattern, grid layout, starting point, and finished elevation should be shown on plan view shop drawings, which have been prepared and approved by the designer, installing contractor and/or owner.

B. GRID LAYOUT AND ELEVATIONS:

1. Once the starting point and the finished elevation of the deck surface have been determined, the "Top of Pedestal Elevation" (finished elevation less decking paver or tile thickness) is established and marked around the perimeter using a transit water level or laser leveling device.

2. Precise measurements should be taken and deck area should be accurately defined. Mark off and 'square up' all outside edges with control lines using "snapped" chalk lines. Mark two (2) lines that are perpendicular to each other across the deck area. Continue to mark a grid of lines in both directions marking the location of each pedestal. Use the control lines as references to periodically check and assure a square layout during installation.
3. Next, a pedestal must be placed where each measured grid line meets the perimeter. Remove two (2) spacer tabs in line with one another atop each pedestal system placed around the perimeter. Remove all four (4) spacer tabs at corners.
4. Adjust each pedestal height to the "Top of Pedestal Elevation" marked on the perimeter. Position the pedestal as close to the edge of the perimeter as possible, with the two remaining spacer tabs aligned with the grid line. Using the elevation marked on the perimeter, stretch a mason's line along and slightly ahead of the second row of pedestals. A laser leveling device may also be used for this purpose.
5. On larger decks, it is recommended that Tile Tech Pedestal System be pre-assembled and pre-set to the proper elevation and placed in position prior to the installation of decking paver or tile.
6. As the pedestals located along the grid lines are loaded with pavers or tiles, fine vertical height adjustment can be made by inserting and rotating, from the top, a T-handle Hex Key in to the Uni-Insert™ of the Pedestal assembly. Clockwise rotation of the Uni-Insert™ will raise the bearing surface and the deck. Counter-clockwise rotation will lower the top bearing surface and deck.
7. Always maintain adequate thread engagement. Tile Tech Pedestal Uni-Insert™ contains a locking tab that will not allow the screw to extend past its maximum extension. Never use if the locking tab is broken. If the height required goes beyond the Uni-Insert™ limit re-cut PVC pipe to the correct height and re-assemble the pedestal using the correct size pipe.
8. Slight irregularities in decking paver or tile thickness can be compensated for by using one (1) to two (2) shim segments. Place on top of the pedestal, under the corner(s) of the decking paver or tile. Use no more than two (2) shims on top of the pedestal and always adhere quartered (1/4) wedges with construction adhesive.
9. Stak-Cap™ Pedestal can be used for limited and or fixed height requirements. Complete deck and grid layout as instructed above. Stack no more than five (5) fixed height Stak-Cap™ Pedestals together and place in lieu of Uni-Just™ Pedestals where needed. Stak-Cap™ Pedestal can also be used with PVC pipe to reduce cost. Spacer tabs can be removed to accommodate perimeter and corner support locations.

C. SLOPE AND HEIGHT COMPENSATION:

1. Stak-Cap™ Pedestals can provide limited slope and height compensation to maintain a level decking surface over sloping substrates and is accomplished using a combination of the following:

    a. Rotate and stack one cap in relation to another to change slope and add height. Each cap will add ½-inch of height and provide 1% slope. Stack no more than 5 caps.
    b. Can also be used with PVC Pipe cut to required height of maximum of 6-inches.

2. Uni-Just™ Pedestals can provide both slope and height compensation to maintain a level decking surface over sloping substrates and is accomplished using a combination of the following:

a. PVC Pipe cut to varying lengths to compensate for GENERAL height requirements.
b. SCREW extension for PRECISE height adjustment.
c. Self-Leveling cap that pivots and tilts in any direction for slope compensation from 0% to 6%.
d. Additional slope adjustments is achieved by the use of the Base Slop Plates that provide 2% slope per plate and can be stacked to a maximum of 5 units to obtain 10% slope.

3. Tile Tech Pedestals are designed to be rotated for final precise adjustment when they are fully loaded. Pedestals should be leveled in each succeeding row as the installation proceeds. Final height adjustment or maintenance is easily made by simply using a T-handle Hex Key that allows you to adjust the pedestals without removing the pavers. T-handle Hex Key is inserted between the four paver corners to engage Uni-Insert™ portion and is adjusted clockwise or counter clockwise to level as needed.
4. Uni-Shims™ may be used in multiples, whole or quarters, and placed under the pedestal base or on top the pedestal cap to level pedestals. Use a small amount of construction adhesive to adhere sections of shims and/or whole shims to each other or to the pedestal. DO NOT use construction adhesive to adhere pedestal or shims to insulation, roofing or waterproofing membrane. Additional sections of shims may be used and should be available for regular maintenance.

## 3.4 PERIMETER CONTAINMENT

A. Any area of the pedestal deck that is not restrained by a parapet or foundation wall must be 'boxed-in' and contained. The deck panels will move if all sides are not adequately restrained. Perimeter framing and edging boards located at the outside of the deck perimeter must be installed to provide restraint. No movement should be allowed at the perimeter of the deck system greater than one tab width.

## 3.5 FIELD QUALITY CONTROL

A. Inspect often during installation to assure that grid spacer lines are being maintained in a straight and consistent pattern and that deck pavers or tiles are level and not rocking. Unless otherwise specified in writing to allow for expansion, inspect to assure that all paver spacing between tiles and at perimeter walls does not exceed a tab width. Particular attention should be made to assure that all pedestrian entry or access points to the deck are level and that the deck surface tiles are not randomly raised or uneven creating a tripping or safety hazard.

B. Confirm that deck pedestal height excess of sixteen (16) inches have been braced in accordance with Tile Tech Inc written instructions.

## 3.6 ROUTINE MAINTENANCE AND CARE

A. The deck owner must perform routine maintenance of the deck. Check for rocking pavers and adjust using T-Handle Hex Key or shim immediately. Pedestals can settle and may have to be realigned. Failure to do so can cause a tripping hazard. Periodically check spacer tabs and

immediately replace broken tabs to limit deck movement. Make sure the edge restraint stays intact and structurally sound.

B. Extra Materials: Deliver supply of maintenance materials to the owner. Furnish not less than 1 percent maintenance materials from same lot as materials installed, and enclosed in protective packaging with appropriate identifying labels.

**END OF SECTION**

**SECTION 07 81 00**

**APPLIED FIREPROOFING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes sprayed fire-resistive materials.

### 1.3 DEFINITIONS

A. SFRM: Sprayed fire-resistive materials.

### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

### 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Framing plans or schedules, or both, indicating the following:

1. Extent of fireproofing for each construction and fire-resistance rating.
2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
3. Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
4. Treatment of fireproofing after application.

### 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Product Certificates: For each type of fireproofing.

C. Evaluation Reports: For fireproofing, from ICC-ES.

D. Preconstruction Test Reports: For fireproofing.

E. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test for compliance with requirements for specified performance and test methods.

1. Bond Strength: Test for cohesive and adhesive strength according to ASTM E 736. Provide bond strength indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
2. Density: Test for density according to ASTM E 605. Provide density indicated in referenced fire-resistance design, but not less than minimum specified in Part 2.
3. Verify that manufacturer, through its own laboratory testing or field experience, attests that primers or coatings are compatible with fireproofing.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, obtain applied-fireproofing manufacturer's written instructions for corrective measures including the use of specially formulated bonding agents or primers.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F (7 deg C) or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.

B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.

C. Fire-Resistance Design: Indicated on Drawings. Identify products with appropriate markings of applicable testing agency.

1. Steel members are to be considered unrestrained unless specifically noted otherwise.

D. Asbestos: Provide products containing no detectable asbestos.

## 2.2 SPRAYED FIRE-RESISTIVE MATERIALS

A. Sprayed Fire-Resistive Material for Interior Applications, Concealed: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carboline Company; a subsidiary of RPM International.
b. GCP Applied Technologies Inc.
c. Isolatek International.
d. Southwest Fireproofing Products Co.

2. Bond Strength: Minimum 430-lbf/sq. ft. (20.59-kPa) cohesive and adhesive strength based on field testing according to ASTM E 736.
3. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E 605.
4. Thickness: As required for fire-resistance design indicated.
5. Combustion Characteristics: ASTM E 136.
6. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 0.
b. Smoke-Developed Index: 0.

7. Compressive Strength: Minimum 8.33 psi (51 kPa) according to ASTM E 761.
8. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
9. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
11. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) maximum in 24 hours according to ASTM E 859.
12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G 21.

B. Sprayed Fire-Resistive Material for Interior Applications, Exposed to Damage or Moisture: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carboline Company; a subsidiary of RPM International.
    b. GCP Applied Technologies Inc.
    c. Isolatek International.
    d. Southwest Fireproofing Products Co.

2. Bond Strength: Minimum 430-lbf/sq. ft. (20.59-kPa) cohesive and adhesive strength based on field testing according to ASTM E 736.
3. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E 605.
4. Thickness: As required for fire-resistance design indicated.
5. Combustion Characteristics: ASTM E 136.
6. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 0.
    b. Smoke-Developed Index: 0.

7. Compressive Strength: Minimum 100 psi (689 kPa) according to ASTM E 761.
8. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
9. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
11. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. (0.270 g/sq. m) maximum in 24 hours according to ASTM E 859.
12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G 21.

## 2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:

1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E 736.

C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fireproofing manufacturer's written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive fireproofing.

E. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fireproofing manufacturer.

F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.

1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
2. Verify that objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
3. Verify that substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.

B. Verify that concrete work on steel deck is complete before beginning fireproofing work.

C. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning fireproofing work.

D. Conduct tests according to fireproofing manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.

B. Clean substrates of substances that could impair bond of fireproofing.

C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.

D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

## 3.3 APPLICATION

A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.

1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.

D. Metal Decks:

1. Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, is completed.
2. Do not apply fireproofing to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fireproofing.

E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

F. Spray apply fireproofing to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.

G. Extend fireproofing in full thickness over entire area of each substrate to be protected.

H. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.

I. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.

J. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.

K. Cure fireproofing according to fireproofing manufacturer's written instructions.

L. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.

## 3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Test and inspect in accordance with Section 01 40 00 “Quality Requirements”.

B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

C. Fireproofing will be considered defective if it does not pass tests and inspections.

1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

D. Prepare test and inspection reports.

## 3.5 CLEANING, PROTECTING, AND REPAIRING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing is without damage or deterioration at time of Substantial Completion.

C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

D. Repair fireproofing damaged by other work before concealing it with other construction.

E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

**END OF SECTION**

**SECTION 07 84 13**

**PENETRATION FIRESTOPPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Requirements:

1. Section 07 84 43 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

### 1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

### 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

        1) UL in its "Fire Resistance Directory."
        2) Intertek Group in its "Directory of Listed Building Products."
        3) FM Global in its "Building Materials Approval Guide."

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.

## 2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. A/D Fire Protection Systems Inc.
c. DAP Inc.
d. Firestop Systems Inc.
e. Hilti, Inc.
f. Tremco, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

E. Putty Pads: Putty pads for back of wall side of outlets in walls (rated and non-rated). Wrap back and sides of electrical or communications back-boxes with intumescent fire-rated moldable putty pads.

1. 3M: Fire Barrier Moldable Putty Pads MPP+.
2. Metacaulk: Fire-rated putty pads.
3. Tremco: Tremstop MP.
4. Hilti: CP 617 Firestop Putty Pads.
5. GCP Applied Technologies: Flamesafe FSP 1077 putty pads.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

## 3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name

## 3.5 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

**END OF SECTION**

**SECTION 07 84 43**

**JOINT FIRESTOPPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints at exterior curtain-wall/floor intersections.
3. Joints in smoke barriers.

B. Related Requirements:

1. Section 07 84 13 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.
2. Section 09 22 16 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

### 1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

### 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."
2) Intertek Group in its "Directory of Listed Building Products."

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.

2.2 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. A/D Fire Protection Systems Inc.
c. DAP Inc.
d. Firestop Systems Inc.
e. Hilti, Inc.
f. Tremco, Inc.

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E 2307.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. Tremco, Inc.

2. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

D. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Surface Cleaning: Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

### 3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections according to ASTM E 2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

**END OF SECTION**

**SECTION 07 92 00**

**JOINT SEALANTS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Mildew-resistant joint sealants.
5. Seacant Primers

**Commented [H2]:** Check spelling

### 1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

### 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:

1. Joint-sealant location and designation.
2. Manufacturer and product name.
3. Type of substrate material.
4. Proposed test.
5. Number of samples required.

C. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

D. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

E. Field-Adhesion-Test Reports: For each sealant application tested.

F. Sample Warranties: For special warranties.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

## 1.7 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with masonry substrates.
4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.

5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.9 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

**PART 2 - PRODUCTS**

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 MATERIALS

A. Type 1 -- Silicone, Nonstaining, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT. Low Modulus, Nonacid-Curing. Nonstaining to porous substrates per ASTM C 1248.

1. Products: Subject to compliance with requirements, provide the following:

    a. Dow Corning Corporation; 790 Silicone Building Sealant
    b. Tremco Global Sealants; Spectrem 1
    c. Pecora Corporation; 890
    d. GE Construction Sealants; SilPruf SCS-9000 NB.
    e. Sika Corporation U.S.; Sikasil WS-290.

B. Type 2 -- Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT. Nonstaining to porous substrates per ASTM C 1248.

1. Products: Subject to compliance with requirements, provide the following:

    a. Dow Corning Corporation; 756 SMS.
    b. Tremco Incorporated; Spectrem 2.
    c. Pecora Corporation; 864NST
    d. GE Construction Sealants; Momentive Performance Materials Inc; Silpruf SCS-2000.
    e. Sika Corporation U.S.; Sikasil WS-295 FPS.

C. Type 3 – Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, provide the following:

    a. BASF Construction Chemicals - Building Systems; MasterSeal NP1.(class 35)
    b. Tremco Incorporated; Vulkem 116.
    c. Pecora Corporation; Dynatrol I-XL.
    d. Sika Corporation U.S.; Sikaflex 1A.(class 35)

## 2.3 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## 2.4 MISCELLANEOUS MATERIALS

A. Primer: Material for adhesion of sealant to joint substrates indicated

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.

B. Joint Priming: Prime joint substrates. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint- sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

## 3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Unless otherwise directed, use the following width to depth ratios:
   a. Joints up to ½ inch wide: 1:1 min. ¼" width and depth
   b. Joints greater than ½ inch wide: 2:1
   c. Joints greater than 1 inch wide: depth shall not exceed ½"
   d. Joints greater than 2 inches wide: consult with Manufacture.

F. Tooling of Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

   a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

## 3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed, and cured sealant joints as follows:

   a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
   b. Perform one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

a. Whether sealants filled joint cavities and are free of voids.
b. Whether sealant dimensions and configurations comply with specified requirements.
c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

## 3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

## 3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

## 3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces **[Type 1]**.

1. Joint Locations:

a. Construction joints in cast-in-place concrete.

b. Control and expansion joints in masonry.
c. Joints between plant-precast architectural concrete units.
d. Control and expansion joints in plaster soffit and overhead surfaces
e. Joints between different materials listed above.
f. **<Insert other joints>**.
g. Other joints as indicated on Drawings.

2. Joint Sealant: **[Type 1]**.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces **[Type 2]**.

1. Joint Locations:

a. Joints in dimension stone cladding.
b. Upward facing joints at **[terra cotta] [GFRC]** and **[stone]** sill and copings
c. Exterior Metal to Metal joints.
d. Joints between metal panels.
e. Joints between different materials listed above.
f. Exterior perimeter joints between materials listed above and frames of **[doors] [windows] [and] [louvers]**.
g. **<Insert other joints>**.
h. Other joints as indicated on Drawings.

2. Joint Sealant: **[Type 2]**.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior moving joints in vertical surfaces and horizontal nontraffic surfaces **[Type 1] [Type3]**.

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Perimeter joints of exterior openings where indicated.
c. Tile control and expansion joints.
d. Vertical joints on exposed surfaces of **[unit masonry] [concrete] [walls] [and] [partitions]**.
e. Perimeter joints between interior wall surfaces and frames.
f. Joints on underside of plant-precast structural concrete **[beams] [and] [planks]**.
**g. <Insert other joints>.**
h. Other joints as indicated on Drawings.

2. Joint Sealant: **[Type 1] [Type3]**.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

**END OF SECTION**

**SECTION 08 11 13**

**HOLLOW METAL DOORS AND FRAMES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes hollow-metal work.

B. Related Sections:

1. Section 042200 “Concrete Masonry Units” for frames at masonry openings.
2. Section 087100 “Door Hardware” for door hardware for hollow-metal doors.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, **fire-resistance ratings** and finishes.

B. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amweld International, LLC.
2. Apex Industries, Inc.
3. Ceco Door Products; an Assa Abloy Group company.
4. Commercial Door & Hardware Inc.
5. Concept Frames, Inc.
6. Curries Company; an Assa Abloy Group company.
7. Custom Metal Products.
8. Daybar.
9. Deansteel.
10. de La Fontaine Industries.
11. DKS Steel Door & Frame Sys. Inc.
12. Door Components, Inc.
13. Fleming-Baron Door Products.
14. Gensteel Doors Inc.
15. Greensteel Industries, Ltd.
16. HMF Express.
17. Hollow Metal Inc.
18. Hollow Metal Xpress.
19. J/R Metal Frames Manufacturing, Inc.
20. Karpen Steel Custom Doors & Frames.
21. L.I.F. Industries, Inc.
22. LaForce, Inc.
23. Megamet Industries, Inc.
24. Mesker Door Inc.
25. Michbi Doors Inc.
26. MPI Group, LLC (The).
27. National Custom Hollow Metal.
28. North American Door Corp.
29. Pioneer Industries, Inc.
30. Premier Products, Inc.

31. Rocky Mountain Metals, Inc.
32. Security Metal Products Corp.
33. Shanahans Manufacturing Ltd.
34. Steelcraft; an Ingersoll-Rand company.
35. Steward Steel; Door Division.
36. Stiles Custom Metal, Inc.
37. Titan Metal Products, Inc.
38. Trillium Steel Doors Limited.
39. West Central Mfg. Inc.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

## 2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

## 2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.

1. Physical Performance: Level B according to SDI A250.4.
2. Doors:

    a. Type: As indicated in the Door and Frame Schedule.
    b. Thickness: 1-3/4 inches.
    c. Face: **Uncoated** cold-rolled steel sheet, minimum thickness of 0.042 inch.
    d. Edge Construction: **Model 1, Full Flush**.
    e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.

3. Frames:

    a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
    b. Construction: Full profile welded.

4. Exposed Finish: Factory Prime

5. Field Painted: Color by Architect

2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3.

1. Physical Performance: Level A according to SDI A250.4.
2. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches
c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
d. Edge Construction: **Model 1, Full Flush**.
e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.

1) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than **2.1 deg F x h x sq. ft./Btu** when tested according to ASTM C 1363.

3. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
b. Construction: Full profile welded.

4. Exposed Finish: Factory Prime

5. Field Painted: Color by Architect

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Post-installed Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

## 2.6 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

C. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

G. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

H. Glazing: Comply with requirements in Section 088000 "Glazing."

I. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

## 2.7 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs

spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.

2. Fire Door Cores: As required to provide fire-protection ratings indicated.
3. Vertical Edges for Single-Acting Doors: **Provide beveled or square edges at manufacturer's discretion**.
4. Top Edge Closures: Close top edges of doors with **inverted closures, except provide flush closures at exterior doors** of same material as face sheets.
5. Bottom Edge Closures: Close bottom edges of doors **where required for attachment of weather stripping** with end closures or channels of same material as face sheets.
6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
7. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. **Sidelight** Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:

        1) Two anchors per jamb up to 60 inches high.
        2) Three anchors per jamb from 60 to 90 inches high.
        3) Four anchors per jamb from 90 to 120 inches high.
        4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

    b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

        1) Three anchors per jamb up to 60 inches high.
        2) Four anchors per jamb from 60 to 90 inches high.
        3) Five anchors per jamb from 90 to 96 inches high.
        4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.

c. Compression Type: Not less than two anchors in each frame.
d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

6. Head Anchors: Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
7. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

8. Terminated Stops: Terminate stops 6 **inches** above finish floor with a **45** degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with **butted** hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow-metal work.
5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

## 2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

**2.** Field Painted: **Color by Architect**

2.9 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. At fire-rated openings, install frames according to NFPA 80.
b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
c. Install frames with removable stops located on secure side of opening.
d. Install door silencers in frames before grouting.

e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
5. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.
8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
c. At Bottom of Door: 5/8 inch plus or minus 1/32 inch.
d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

## 3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that iswarped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

**END OF SECTION**

**SECTION 08 14 16**

**FLUSH WOOD DOORS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Solid-core doors with **wood-veneer** faces.
2. Hollow-core doors with **wood-veneer** faces.
3. **Factory finishing** flush wood doors.
4. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Sections:

1. Section 062023 "Interior Finish Carpentry".
2. Section 081113 “Hollow Metal Doors and Frames”
3. Section 099100 "Finish Painting"

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door indicated. Include details of core and edge construction.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.

1. Indicate dimensions and locations of mortises and holes for hardware.
2. Indicate dimensions and locations of cutouts.
3. Indicate doors to be factory finished and finish requirements.
4. Indicate fire-protection ratings for fire-rated doors.

C. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 6 by 6 inches, for each material and finish.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors from single manufacturer.

B. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated." WDMA I.S.1-A, "Architectural Wood Flush Doors." WI's "Manual of Millwork."

1. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure as close to neutral pressure as possible according to NFPA 252.

D. Certified Wood: For door wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship". No Lauan doors.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in **plastic bags or cardboard cartons**.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.
4. Warranty Period for Hollow-Core Interior Doors: **Two** year(s) from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Algoma Hardwoods, Inc.
2. Ampco, Inc.
3. Buell Door Company Inc.
4. Chappell Door Co.
5. Eagle Plywood & Door Manufacturing, Inc .
6. Eggers Industries.
7. Graham; an Assa A bloy Group company.
8. Haley Brothers, Inc.
9. Ideal Architectural Doors & Plywood.
10. Ipik Door Company.
11. Lambton Doors.
12. Marlite.
13. Marshfield Door Systems, Inc.
14. Mohawk Flush Doors, Inc.; a Masonite company.
15. Oshkosh Architectural Door Company.
16. Poncraft Door Company.
17. Vancouver Door Company.
18. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

A. WDMA I.S.1-A Performance Grade:

1. Heavy Duty: Tenant solid core (45 minute) unit entry flush wood veneer doors and rated HM frames.
2. Standard Duty: Tenant hollow core interior flush doors and bi-folds w/ wood frames – non rated.
3. Standard Duty: Tenant MagicPak (mechanical unit) flush wood door, concealed frame, special hardware.

B. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.

1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.

2. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. **Provide stiles with concealed intumescent seals.** Comply with specified requirements for exposed edges.
3. Pairs: Provide formed-steel edges and astragals **with intumescent seals**.

    a. Finish steel edges and astragals with baked enamel **same color as doors**.
    b. Finish steel edges and astragals to match door hardware (locksets or exit devices).

C. Hollow-Core Doors:

1. Construction: **Institutional** hollow core.
2. Blocking: Provide wood blocking with minimum dimensions as follows:

    a. 5-by-18-inch lock blocks **at both stiles**.
    b. 5-inch top- **and bottom-**rail blocking.
    c. 10-inch **top- and** bottom-rail blocking.
    d. 2-1/2-inch midrail blocking.

## 2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors (Fire Rated Tenant Entry Doors):

1. Grade: **Premium, with Grade A faces**.
2. Species: **Figured select white ash**.
3. Cut: **Plain sliced (flat sliced)**.
4. Match between Veneer Leaves: **Book** match.
5. Exposed Vertical Edges: **Same species as faces or a compatible species**.
6. WDMA I.S.1-A Performance Grade: **Heavy Duty**.

## 2.4 DOORS FOR OPAQUE FINISH

A. Interior Hollow-Core Doors: Pre-hung

1. Grade: Economy.
2. Faces: Any closed-grain hardwood of mill option.
3. Exposed Vertical and Top Edges: Any closed-grain hardwood.
4. Construction: Seven plies.
5. WDMA I.S.1-A Performance Grade: Standard Duty.

## 2.5 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.

1. Comply with requirements in NFPA 80 for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

## 2.6 SHOP PRIMING

A. Doors for Opaque Finish: Field prime doors with one coat of wood primer specified in **Section 099100 "Interior Painting."** Seal all four edges, edges of cutouts, and mortises with primer.

B. Doors for Transparent Finish: Shop prime doors with stain (if required), other required pretreatments, and first coat of finish as specified in **Section 099100 "Interior Painting."** Seal all four edges, edges of cutouts, and mortises with first coat of finish.

## 2.7 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on **top and** bottom edges, edges of cutouts, and mortises.

B. Finish doors at factory.

C. Finish doors at factory that are indicated to receive transparent finish. Field finish doors indicated to receive opaque finish.

D. Finish doors at factory where indicated in schedules or on Drawings as factory finished.

E. Use only paints and coatings that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Transparent Finish:

1. Finish: AWI **catalyzed polyurethane** system.
2. Sheen: **Semigloss**.

G. Opaque Finish:

1. Color: **Match Architect's sample**.
2. Sheen: **Semigloss**.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine doors and installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware".

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.

1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.

a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
3. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

### 3.3 ADJUSTING

A. Operation: Re-hang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

**END OF SECTION**

**SECTION 08 31 13**

**ACCESS DOORS AND FRAMES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Access doors and frames for walls and ceilings.
2. Floor access doors and frames.

B. Related Requirements:

1. Section 077200 "Roof Accessories" for roof hatches.

1.3 ALLOWANCES

A. Access doors and frames are part of an access door and frame allowance.

1.4 ACTION SUBMITTALS

A. Product Data: Submit complete printed data for each type of door and frame. Include construction details relative to materials, individual components and profiles, finishes, and fire ratings (if required).

B. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

## PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
2. NFPA 288 for fire-rated access door assemblies installed horizontally.

## 2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:

1. Access Panel Solutions.
2. Acudor Products, Inc.
3. Alfab, Inc.
4. Babcock-Davis.
5. Cendrex Inc.
6. Elmdor/Stoneman Manufacturing Co.; Div. of Acorn Engineering Co.
7. Jensen Industries; Div. of Broan-Nutone, LLC.
8. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
9. Karp Associates, Inc.
10. Larsen's Manufacturing Company.
11. Maxam Metal Products Limited.
12. Metropolitan Door Industries Corp.
13. MIFAB, Inc.
14. Milcor Inc.
15. Nystrom, Inc.
16. Williams Bros. Corporation of America (The).

C. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

D. Flush Access Doors with Exposed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Locations: **Wall and ceiling**.
3. Door Size: See documents or as required.
4. Metallic-Coated Steel Sheet for Door: **Nominal 0.064 inch, 16 gage**.

    a. Finish: **Factor Prime**.

5. Frame Material: **Same material, thickness, and finish as door**.
6. Hinges: **Manufacturer's standard**.
7. Hardware: **Lock**.

E. Fire-Rated, Flush Access Doors with Exposed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame, **with a core of mineral-fiber insulation enclosed in sheet metal**. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Locations: **Wall and ceiling**.

3. Fire-Resistance Rating: Not less than **that indicated**.
4. Metallic-Coated Steel Sheet for Door: **Nominal 0.040 inch, 20 gage**.

    a. Finish: **Factory prime**.

5. Frame Material: **Same material, thickness, and finish as door**.
6. Hinges: **Manufacturer's standard**.
7. Hardware: **Lock**.

F. Hardware:

1. Latch: **Cam latch** operated **by flush key**.
2. Lock: **Cylinder**.

## 2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M..

B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793, manufacturer's standard finish.

F. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

G. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

H. Aluminum Sheet: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15; with minimum sheet thickness according to ANSI H35.2.

I. Frame Anchors: Same type as door face.

J. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

## 2.4 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. Provide mounting holes in frames for attachment of units to metal or wood framing.
2. Provide mounting holes in frame for attachment of masonry anchors.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder locks, furnish two keys per lock and key all locks alike.
2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

E. Extruded Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Steel and Metallic-Coated-Steel Finishes:

1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
2. Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry-film thickness of 1 mil for topcoat.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

**END OF SECTION**

**SECTION 08 41 13**

**ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Kawneer Architectural Aluminum Storefront Systems, including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing of storefront units.

1. Types of Kawneer Aluminum Storefront Systems include:

a. Trifab™ 601 Framing System – 2" x 6" (50.8 mm x 152.4 mm) nominal dimension; Non-Thermal; Center Plane; Screw Spline Fabrication.
b. Trifab™ 601T Framing System – 2" x 6" (50.8 mm x 152.4 mm) nominal dimension; Thermal; Center Plane; Screw Spline Fabrication.

B. Related Sections:

1. 072700 “Air Barriers”
2. 079200 “Joint Sealants”
3. 084413 “Glazed Aluminum Curtain Walls”
4. 085113 “Aluminum Windows”
5. 087100 “Door Hardware”
6. 087113 “Automatic Door Operators”
7. 088000 “Glazing”

1.3 DEFINITIONS

A. Definitions: For fenestration industry standard terminology and definitions refer to American Architectural Manufacturers Association (AAMA) – AAMA Glossary (AAMA AG).

1.4 PERFORMANCE REQUIREMENTS

A. Storefront System Performance Requirements:

1. Wind loads: Provide storefront system; include anchorage, capable of withstanding wind load design pressures of (____) lbs./sq. ft. inward and (____) lbs./sq. ft. outward. The design pressures are based on the Chicago Building Code; 2019 Edition.

2. Air Leakage: The test specimen shall be tested in accordance with ASTM E 283. Air Leakage rate shall not exceed 0.06 cfm/ft$^2$ at a static air pressure differential of 6.2 psf with interior seal, or, rate shall not exceed 0.06 cfm/ft$^2$ at a static air pressure differential of 1.6 psf without interior seal. CSA A440 Fixed Rating.
3. Water Resistance: The test specimen shall be tested in accordance with ASTM E 331. There shall be no leakage at a minimum static air pressure differential of 10 psf (500 Pa) as defined in AAMA 501. CSA A440 B5 Rating.
4. Uniform Load: A static air design load of 30 psf (1437 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of L/175 of the span of any framing member. At a structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur. CSA A440 C2 Rating.
5. Energy Efficiency:

    a. Thermal Transmittance (U-factor): When tested to AAMA Specification 1503, the thermal transmittance (U-factor) shall not be more than:

        1) Trifab™ 601 – 0.53 (low-e) or Project Specific (____) BTU/hr/ft2/°F. As determined per AAMA 507 or NFRC 100.
        2) Trifab™ 601T – 0.35 (low-e) or Project Specific (____) BTU/hr/ft2/°F. As determined per AAMA 507 or NFRC 100.
        3) Trifab™ 601UT – 0.33 (low-e) or Project Specific (____) BTU/hr/ft$^2$/°F. As determined per AAMA 507 or NFRC 100.

6. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than:

    a. Trifab™ 601 – $41_{frame}$ and $63_{glass}$(low-e).
    b. Trifab™ 601T – $69_{frame}$ and $70_{glass}$(low-e).
    c. Trifab™ 601UT – $74_{frame}$ and $70_{glass}$(low-e).

7. Sound Transmission Class (STC) and Outdoor-Indoor Transmission Class (OITC): When tested to AAMA Specification 1801 and in accordance with ASTM E1425 and ASTM E90, the STC and OITC Rating shall not be less than:

    a. Trifab™ 601/601T/601UT – 37 (STC) and 31 (OITC).

8. Windborne-Debris-Impact Resistance Performance: Shall be tested in accordance with ASTM E 1886, information in ASTM E 1996 and TAS 201/203.

    a. Large-Missile Impact: For aluminum-framed systems located within 30 feet (9.1 m) of grade.
    b. Small-Missile Impact: For aluminum-framed systems located above 30 feet (9.1 m) of grade.

9. Material Ingredient Reporting: Shall have a complete list of chemical ingredients to at least 100ppm (0.01%) that covers 100% of the product, acceptable documentation includes:

    a. Manufacturer's inventory with Chemical Abstract Service Registration Number (CASRN or CAS#).

1) Kawneer's Material Transparency Summary (MTS).

b. Trifab™ 601T Cradle to Cradle certification: Either document below is acceptable for this option.

1) Cradle to Cradle Certified™ with Material Health section Silver or above.
2) Silver level or above Material Health Certificate.

10. Red List Free DECLARE label.

B. Environmental Product Declaration (EPD): Shall have a Type III Product-Specific EPD created from a Product Category Rule.

C. Material Ingredient Reporting: Shall have a complete list of chemical ingredients to at least 100ppm (0.01%) that covers 100% of the product, acceptable documentation includes:

1. Manufacturer's inventory with Chemical Abstract Service Registration Number (CASRN or CAS#).

a. Kawneer's Material Transparency Summary (MTS).

1.5 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, hardware, finishes, and installation instructions for each type of aluminum-framed storefront system indicated.

1. Recycled Content:

a. Provide documentation that aluminum has a minimum of 50% mixed pre- and post-consumer recycled content with a sample document illustrating project specific information that will be provided after product shipment.
b. Once product has shipped, provide project specific recycled content information, including:

1) Indicate recycled content; indicate percentage of pre- and post-consumer recycled content per unit of product.
2) Indicate relative dollar value of recycled content product to total dollar value of product included in project.
3) Indicate location recovery of recycled content.
4) Indicate location of manufacturing facility.

2. Environmental Product Declaration (EPD):

a. Include a Type III Product-Specific EPD created from a Product Category Rule.

3. Material Ingredient Reporting:

a. Include documentation for material reporting that has a complete list of chemical ingredients to at least 100ppm (0.01%) that covers 100% of the product.

B. Shop Drawings: Include plans, elevations, sections, details, hardware, and attachments to other work, operational clearances and installation details.

C. Samples for Initial Selection: For units with factory-applied color finishes including samples of hardware and accessories involving color selection.

D. Samples for Verification: For aluminum-framed storefront system and components required.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for each type of aluminum-framed storefront.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of aluminum-framed systems, made from 12" lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

G. Other Action Submittals:

1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer which has had successful experience with installation of the same or similar units required for the project and other projects of similar size and scope.

B. Manufacturer Qualifications: A manufacturer capable of providing aluminum framed storefront system that meet or exceed performance requirements indicated and of documenting this performance by inclusion of test reports, and calculations.

C. Source Limitations: Obtain aluminum-framed storefront system through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of aluminum-framed storefront system and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements”. Do not modify size and dimensional requirements.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup for type(s) of storefront elevation(s) indicated, in location(s) shown on Drawings.

F. Pre-installation Conference: Conduct conference at Project Site to comply with requirements in Division 01 Section “Project Management and Coordination”.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of aluminum-framed storefront openings by field measurements before fabrication and indicate field measurements on Shop Drawings.

1.8 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty.

1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by manufacturer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Basis-of-Design Product:

1. Kawneer Company Inc.
2. Trifab™ 601 Framing System (Non-Thermal)
3. Trifab™ 601T Framing System (Thermal)
4. System Dimensions: 2" x 6"
5. Glass: Exterior or Interior Glazed, as indicated in the Drawings.

B. Subject to compliance with requirements, provide a comparable product by the following:

1. Manufacturer: (_____)
2. Series: (_____)
3. Profile dimension: 2" x 6"

C. Substitutions: Refer to Substitutions Section for procedures and submission requirements.

1. Pre-Contract (Bidding Period) Substitutions: Submit written requests ten (10) days prior to bid date.
2. Post-Contract (Construction Period) Substitutions: Submit written request in order to avoid storefront installation and construction delays.
3. Product Literature and Drawings: Submit product literature and drawings modified to suit specific project requirements and job conditions.
4. Certificates: Submit certificate(s) certifying substitute manufacturer (1) attesting to adherence to specification requirements for storefront system performance criteria, and

(2) has been engaged in the design, manufacturer and fabrication of aluminum storefronts for a period of not less than ten (10) years. (Company Name)

5. Test Reports: Submit test reports verifying compliance with each test requirement required by the project.
6. Samples: Provide samples of typical product sections and finish samples in manufacturer's standard sizes.

D. Substitution Acceptance: Acceptance will be in written form, either as an addendum or modification, and documented by a formal change order signed by the Owner and Contractor.

2.2 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by aluminum storefront manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" wall thickness at any location for the main frame and complying with ASTM B 221: 6063-T6 alloy and temper.

1. Recycled Content: Shall have a minimum of 50% mixed pre- and post-consumer recycled content.

a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product
b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
c. Indicate location recovery of recycled content.
d. Indicate location of manufacturing facility.

B. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum members, trim hardware, anchors, and other components.

C. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

E. Sealant: For sealants required within fabricated storefront system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

F. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.

G. Red List Free: All parts and materials comply with the Living Building Challenge/DECLARE Red List and the Cradle-to-Cradle (C2C) Banned List.
1. PVC free
2. Neoprene free

## 2.3 STOREFRONT FRAMING SYSTEM

A. Thermal Barrier:

1. Trifab™ 601T: Kawneer IsoLock™ Thermal Break with a nominal 1/4" (6.4 mm) separation consisting of a two-part chemically curing, high-density polyurethane, which is mechanically and adhesively joined to aluminum storefront sections

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials. Where exposes shall be stainless steel.

D. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

E. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

F. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle storefront material and components to avoid damage. Protect storefront material against damage from elements, construction activities, and other hazards before, during and after storefront installation.

## 2.4 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section “Glazing”.

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, extruded EPDM rubber.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

E. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type, and as follows:

1. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use.
2. Color: Matching structural sealant.

## 2.5 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: As specified in Division 084113 Section “Aluminum-Framed Entrances and Storefronts”.

B. Entrance Door Hardware: As specified in Division 084113 Section “Door Hardware”.

## 2.6 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section “Joint Sealants”.

B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30 mil thickness per coat.

## 2.7 FABRICATION

A. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fit joints; make joints flush, hairline and weatherproof.
3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

B. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

C. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

D. Storefront Framing: Fabricate components for assembly using manufacturer’s standard installation instructions.

E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## 2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Factory Finishing:

1. Kawneer Permanodic™ AA-M10C21A41 / AA-M45C22A41, AAMA 611, Architectural Class I Clear Anodic Coating (Color #14 Clear) (Optional).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weather tight framed aluminum-storefront system installation.

B. Install aluminum-framed storefront system level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weather tight construction.

D. Install aluminum-framed storefront system and components to drain condensation, water penetrating joints, and moisture migrating within aluminum-framed storefront system to the exterior.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

### 3.2 INSTALLATION

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing aluminum-framed storefront system, accessories, and other components.

B. Install aluminum-framed storefront system level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weather tight construction.

D. Install aluminum-framed storefront system and components to drain condensation, water penetrating joints, and moisture migrating within aluminum-framed storefront system to the exterior.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

## 3.3 FIELD QUALITY CONTROL

A. Field Tests: Architect shall select storefront units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter caulked and cured. Conduct tests for air infiltration and water penetration with manufacturer's representative present. Tests not meeting specified performance requirements and units having deficiencies shall be corrected as part of the contract amount.

1. Testing: Testing shall be performed by a qualified independent testing agency. Refer to Testing Section for payment of testing and testing requirements. Testing Standard per AAMA 503, including reference to ASTM E 783 for Air Infiltration Test and ASTM E 1105 Water Infiltration Test.

   a. Air Infiltration Tests: Conduct tests in accordance with ASTM E 783. Allowable air infiltration shall not exceed 1.5 times the amount indicated in the performance requirements or 0.09 cfm/$ft^2$, whichever is greater.
   b. Water Infiltration Tests: Conduct tests in accordance with ASTM E 1105. No uncontrolled water leakage is permitted when tested at a static test pressure of two-thirds the specified water penetration pressure but not less than 6.2 psf (300 Pa).

B. Manufacturer's Field Services: Upon Owner’s written request, provide periodic site visit by manufacturer’s field service representative.

## 3.4 ADJUSTING, CLEANING AND PROTECTION

A. Clean aluminum surfaces immediately after installing aluminum-framed storefronts. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

B. Clean glass immediately after installation. Comply with glass manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

**END OF SECTION**

**SECTION 08 44 13**

**GLAZED ALUMINUM CURTAIN WALLS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Kawneer Architectural Aluminum Curtain Wall Systems, including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing of curtain wall framing.
2. Types of Kawneer Aluminum Curtain Wall include:

   a. 1620 SSG Curtain Wall System – 2" x 6", outside glazed pressure plate (horizontal frames) or structural silicone glazed (SSG) format (vertical frames).

B. Related Sections:

1. 072700 “Air Barriers”
2. 079200 “Joint Sealants”
3. 083213 “Sliding Aluminum-Framed Glass Doors”
4. 084113 “Aluminum-Framed Entrances and Storefronts”
5. 084313 “Aluminum-Framed Storefronts”
6. 084329 “Sliding Storefronts”
7. 084433 “Sloped Glazing Assemblies”
8. 085113 “Aluminum Windows”
9. 086300 “Metal-Framed Skylights”
10. 088000 “Glazing”
11. 122600 “Interior Daylighting Devices”

### 1.3 DEFINITIONS

A. Definitions: For fenestration industry standard terminology and definitions refer to American Architectural Manufactures Association (AAMA) – AAMA Glossary (AAMA AG).

### 1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads. Failure also includes the following:

    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Loosening or weakening of fasteners, attachments, and other components.
    d. Failure of operating units.

B. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Wind loads: Provide Curtain Wall system; include anchorage, capable of withstanding wind load design pressures of (_ ) lbs./sq. ft. inward and (_ ) lbs./sq. ft. outward. The design pressures are based on the Chicago Building Code; 2019 Edition.

D. Air Infiltration: The test specimen shall be tested in accordance with ASTM E 283. Air infiltration rate shall not exceed 0.06 cfm/ft$^2$ (0.3 l/s · m$^2$) at a static air pressure differential of 6.24 psf (300 Pa).

E. Water Resistance, (static): The test specimen shall be tested in accordance with ASTM E 331. There shall be no leakage at a minimum static air pressure differential of 12 psf (575 Pa) as defined in AAMA 501.

F. Water Resistance, (cyclic): The test specimen shall be tested in accordance with ASTM E 547. There shall be no leakage at a minimum static air pressure differential of 12 psf (575 Pa) as defined in AAMA 501.

G. Water Resistance, (severe, wind driven rain): The test specimen shall be tested in accordance with AAMA 520 and ASTM E2268. There shall be no visible water at performance level 10, pressure limits 14 psf ( 670 Pa) – 42 psf (2010 Pa).

H. Uniform Load: A static air design load of 42 psf (2010 Pa) shall be applied in the positive and negative direction in accordance with ASTM E 330. There shall be no deflection in excess of L/175 of the span of any framing member at design load. At structural test load equal to 1.5 times the specified design load, no glass breakage or permanent set in the framing members in excess of 0.2% of their clear spans shall occur.

I. Captured Performance Requirements:

1. Energy Efficiency:

    a. Thermal Transmittance (U-factor): When tested to AAMA Specification 1503, the thermal transmittance (U-factor) shall not be more than 0.37 (HP glass) or Project Specific ( ) BTU/hr/ft2 /°F. per AAMA 507 or ( ) BTU/hr/ft2 /°F. per NFRC 100.

2. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than $75_{frame}$ and $71_{glass}$ (HP glass).

3. Sound Transmission Loss: When tested to ASTM E90 and ASTM E1425, the Sound Transmission Class (STC) and Outdoor/Indoor Transmission Class (OITC) shall not be less than: STC 34 or OITC 29 based upon 1" (25.4) laminated glass (1/4", 1/2" AS, 1/4" laminated).

J. SSG Performance Requirements:

1. Energy Efficiency:

a. Thermal Transmittance (U-factor): When tested to AAMA Specification 1503, the thermal transmittance (U-factor) shall not be more than 0.38 (HP glass) or Project Specific ( ) BTU/hr/ft2 /°F. per AAMA 507 or ( ) BTU/hr/ft2 /°F. per NFRC 100.

2. Condensation Resistance (CRF): When tested to AAMA Specification 1503, the condensation resistance factor shall not be less than $76_{frame}$ and $70_{glass}$ (HP glass).
3. Sound Transmission Loss (SSG): When tested to ASTM E90 and ASTM E1425, the Sound Transmission Class (STC) and Outdoor/Indoor Transmission Class (OITC) shall not be less than: STC 34 or OITC 29 based upon 1" (25.4) laminated glass (1/4", 1/2" AS, 1/4" laminated).
4. Environmental Product Declaration (EPD): Shall have a Type III Product-Specific EPD created from a Product Category Rule

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1. Recycled Content:

a. Provide documentation that aluminum has a minimum of 50% mixed pre- and post-consumer recycled content with a sample document illustrating project specific information that will be provided after product shipment.
b. Once product has shipped, provide project specific recycled content information, including:

1) Indicate recycled content; indicate percentage of pre- and post-consumer recycled content per unit of product.
2) Indicate relative dollar value of recycled content product to total dollar value of product included in project.
3) Indicate location recovery of recycled content.
4) Indicate location of manufacturing facility.

2. Environmental Product Declaration (EPD).

a. Include a Type III Product-Specific EPD created from a Product Category Rule.

B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified preconstruction testing agency, for glazed aluminum curtain walls, indicating compliance with performance requirements.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of aluminum-framed curtain wall systems, made from 12" (304.8 mm) lengths of full-size components and showing details of the following:

1. Joinery
2. Glazing

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Installer who has had successful experience with installation of the same or similar systems required for the project and other projects of similar size and scope.

B. Manufacturer Qualifications: A manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed performance requirements.

C. Source Limitations: Obtain aluminum curtain wall system through one source from a single manufacturer.

D. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not modify intended aesthetic effects, as judged solely by the Architect, except with Architect’s written approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups for type(s) of curtain wall elevation(s) indicated, in location(s) shown on Drawings.

F. Pre-installation Conference: Conduct conference at Project Site to comply with requirements in Division 01 Section “Project Management and Coordination”.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.

1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by manufacturer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Basis-of-Design Product:

1. Kawneer Company Inc.
2. 1620/1620 SSG Curtain Wall System.
3. Frame depth options: 2" x 6" (50.8 x 152.4) or 2" x 7-1/2" (50.8 x 190.5), outside glazed pressure plate or structural silicone glazed (SSG) format.
4. Tested to AAMA 501.

B. Subject to compliance with requirements, provide a comparable product by the following:
1. Manufacturer: (_____)
2. Series: (_____)
3. Profile Dimension: 2" x 6" or 2" x 7-1/2"

C. Substitutions: Refer to Substitutions Section in Division 01 for procedures and submission requirements.

1. Pre-Contract (Bidding Period) Substitutions: Submit written requests ten (10) days prior to bid date.
2. Post-Contract (Construction Period) Substitutions: Submit written request in order to avoid curtain wall installation and construction delays.
3. Product Literature and Drawings: Submit product literature and drawings modified to suit specific project requirements and job conditions.
4. Certificates: Submit certificate(s) certifying substitute manufacturer (1) attesting to adherence to specification requirements for curtain wall system performance criteria, and (2) has been engaged in the design, manufacturer and fabrication of aluminum curtain walls for a period of not less than ten (10) years. (Company Name).
5. Test Reports: Submit test reports verifying compliance with each test requirement required by the project.
6. Samples: Provide samples of typical product sections and finish samples in manufacturer's standard sizes.

D. Substitution Acceptance: Acceptance will be in written form, either as an addendum or modification, and documented by a formal change order signed by the Owner and Contractor.

## 2.2 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by glazed aluminum curtain wall manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" (1.8) wall thickness at any location for the main frame and complying with ASTM B 221: 6063-T6 alloy and temper.

B. Aluminum sheet alloy: Shall meet the requirements of ASTM B209.

C. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum window members, trim hardware, anchors, and other components.

D. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

E. Pressure Plate: Pressure plate shall be aluminum and fastened to the mullion with stainless steel screws.

F. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicate.

G. Sealant: For sealants required within fabricated curtain wall system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

H. Thermal Barrier: Thermal separator shall be extruded of a silicone compatible elastomer that provides for a minimum separation from interior to exterior metal of ¼" (6mm).

I. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of glazed curtain wall members are nominal and in compliance with AA Aluminum Standards and Data.

## 2.3 CURTAIN WALL FRAMING

A. Framing Members: Manufacturer's standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Glazing System: 4 sided captured.
2. Glazing Plane: Front.

B. Glass: 1" (25.4) insulating glass option. 1/4" (6.4) for Spandrel applications.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with non-staining, nonferrous shims for aligning system components.

D. Framing Sealants: Shall be suitable for glazed aluminum curtain wall as recommended by sealant manufacturer.

E. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, nonbleeding fasteners and accessories compatible with adjacent materials. Where exposed shall be stainless steel.

F. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

G. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

H. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle curtain wall material and components to avoid damage. Protect curtain wall material against damage from elements, construction activities, and other hazards before, during and after installation.

## 2.4 GLAZING

A. Glazing: Comply with Division 08 Section “Glazing”. Following glazing options are available.

1. System: Outside glazed pressure plate format with 1" double glazed insulating glass.

B. Glazing Gaskets: Gaskets to meet the requirements of ASTM C864.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

E. Glazing Sealants: As recommended by manufacturer for joint type.

## 2.5 OPERABLE UNITS

A. Doors: Comply with Division 08 Section “Aluminum-Framed Entrances and Storefronts”.

## 2.6 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

## 2.7 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints.
3. Physical and thermal isolation of glazing from framing members.

4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
7. Internal weeping system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

C. Curtain Wall Framing: Fabricate components for assembly using shear block system following manufacturer's standard installation instructions.

D. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Factory Finishing:

1. Kawneer Permanodic™ AA-M10C21A41 / AA-M45C22A41, AAMA 611, Architectural Class I Clear Anodic Coating (Color #14 Clear) (Optional).

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install curtain wall systems plumb, level, and true to line, without warp or rack of frames with manufacturer’s prescribed tolerances and installation instructions. Provide support and anchor in place.

1. Dissimilar Materials: Provide separation of aluminum materials from sources of corrosion or electrolytic action contact points.
2. Glazing: Glass shall be outside glazed and held in place with extruded aluminum pressure plates anchored to the mullion using stainless steel fasteners spaced no greater than 9" on center.
3. Water Drainage: Each light of glass shall be compartmentalized using joint plugs and silicone sealant to divert water to the horizontal weep locations. Weep holes shall be

located in the horizontal pressure plates and covers to divert water to the exterior of the building.

B. Related Products Installation Requirements:

1. Sealants (Perimeter): Refer to Joint Treatment (Sealants) Section.
2. Glass: Refer to Glass and Glazing Section.

a. Reference: ANSI Z97.1, CPSC 16 CFR 1201 and GANA Glazing Manual.

## 3.3 FIELD QUALITY CONTROL

A. Field Tests: Architect shall select curtain wall units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter caulked and cured. Conduct tests for air infiltration and water penetration with manufacturer's representative present. Tests not meeting specified performance requirements and units having deficiencies shall be corrected as part of the contract amount.

1. Testing: Testing shall be performed per AAMA 503 by a qualified independent testing agency. Refer to Testing Section for payment of testing and testing requirements.
   a. Air Infiltration Tests: Conduct tests in accordance with ASTM E 783. Allowable air infiltration shall not exceed 1.5 times the amount indicated in the performance requirements or 0.09 $cfm/ft^2$, whichever is greater.
   b. Water Infiltration Tests: Conduct tests in accordance with ASTM E 1105. No uncontrolled water leakage is permitted when tested at a static test pressure of two-thirds the specified water penetration pressure but not less than 8 psf.

B. Manufacturer's Field Services: Upon Owner's written request, provide periodic site visit by manufacturer's field service representative.

## 3.4 ADJUSTING, CLEANING AND PROTECTION

A. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum curtain wall system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.

B. Cleaning: Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

**END OF SECTION**

**SECTION 08 51 13**

**ALUMINUM WINDOWS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Kawneer Architectural Aluminum Windows including perimeter trims, stools, accessories, shims and anchors, and perimeter sealing of window units.

1. Types of Kawneer Aluminum Windows include:

a. Kawneer Series AA™6600 Windows - Project-Out Windows

1) Project-Out (Awning) Windows.
2) 6" AA™6600 frame depth
3) 3-9/16" (90.4 mm) Project-In vent depth or 3-3/8" (85.7 mm) Project-Out vent depth.
4) AW-PG70-AP

b. Kawneer Series AA™6600 Windows - Fixed Windows

1) Fixed Windows
2) 6" AA™6600 frame depth
3) AW-PG70-FW

B. Related Sections:

1. 072700 “Air Barriers”
2. 079200 “Joint Sealants”
3. 084113 “Aluminum-Framed Entrances and Storefronts”
4. 084413 “Glazed Aluminum Curtain Walls”
5. 088000 “Glazing”

1.3 DEFINITIONS

A. Definitions: For fenestration industry standard terminology and definitions refer to American Architectural Manufacturers Association (AAMA) – AAMA Glossary (AAMA AG).

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed window system shall withstand the effects of the following performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Window Performance Requirements:

1. Performance Requirements: Provide aluminum windows of performance indicated that comply with AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS).

a. Performance Class and Grade:

1) Projecting Windows (Awning): AW-PG70-AP
2) Fixed Windows: AW-PG70-FW

2. Wind loads: Provide window system; include anchorage, capable of withstanding wind load design pressures of (___ ) lbs./sq. ft. inward and (___ ) lbs./sq. ft. outward. The design pressures are based on the Chicago Building Code; 2019 Edition.
3. Air Infiltration: The test specimen shall be tested in accordance with ASTM E283 at a minimum size of 60" x 36" (1524 x 914). Air infiltration rate shall not exceed 0.10 cfm/$ft^2$ at a static air pressure differential of 6.24 psf (300 Pa). The test specimen shall meet the A3 rating of less than 0.55 ($m^3$/h)/m at 1.57 psf (75 Pa) when tested in accordance with CAN/CSA-A440-00 Windows.
4. Water Resistance: The test specimen shall be tested in accordance with ASTM E547 and ASTM E331 at a minimum size of 60" x 36". There shall be no leakage as defined in the test method at a static air pressure differential of 15 psf. The test specimen shall meet the B7 rating with no water leakage at 15 psf when tested in accordance with CAN/CSA-A440-00 Windows.
5. Uniform Load Deflection: A minimum static air pressure difference of 70 psf shall be applied in the positive and negative direction in accordance with ASTM E330. There shall be no deflection in excess of L/175 of the span of any framing member. The test specimen shall meet the C5 rating when tested in accordance with CAN/CSA-A440-00 Windows.
6. Uniform Load Structural: A minimum static air pressure difference of 105 psf shall be applied in the positive and negative direction in accordance with ASTM E330. The unit shall be evaluated after each load with permanent set not to exceed 0.2% of span length.
7. Component Testing: Window components shall be tested in accordance with procedures described in AAMA/WDMA/CSA 101/I.S.2/A440 and AAMA 910.
8. Energy Efficiency:

a. Thermal Transmittance (U-Factor): When tested to AAMA Specification 1503, AAMA Specification 507 or NFRC 100 the thermal transmittance (U-Factor) shall not be more than:

1) 1" insulating glass:
a) Project-Out: U-Factor not more than .43 BTU/hr/$ft^2$/°F per AAMA 1503 with exterior 1/4" low-e glass, 1/2" Technoform TGI spacer, and interior 1/4" clear glass.
b) Fixed: U-Factor not more than .31 BTU/hr/$ft^2$/°F per AAMA 1503 with exterior 1/4" low-e glass, 1/2" Technoform TGI spacer, and interior 1/4" clear glass

c) Alternative: U-Factor not more than_____BTU/hr/sf/°F per AAMA 507 or NFRC 100 when using project specified glass.

9. Condensation Resistance Test (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, the condensation resistance factor (CFR) shall not be less than:

   a. Project-Out: CRF not less than 71 (frame) and 69 (glass).
   b. Fixed: CRF not less than 77 (frame) and 72 (glass).

10. Temperature Index (I): Provide aluminum windows tested for thermal performance according to CSA-A440 with a Temperature Index (I) not less than:

    a. Project-Out: (I) not less than 62 (frame) and 64 (glass).
    b. Fixed: (I) not less than 73 (frame) and 66 (glass) for AA™6400 and 70 (frame) and 67 (glass) for AA™6500.

11. Sound Transmission Class (STC) and Outdoor-Indoor Transmission Class (OITC): For 1" insulating glass made with exterior 3/16" clear glass, 3/8" aluminum spacer, and interior 7/16" laminated clear glass, when tested in accordance with AAMA Specification 1801, the STC and OITC shall not be less than:

    a. Project-Out: STC not less than 35; OITC not less than 28.
    b. Fixed: STC not less than 38; OITC not less than 32.

12. Forced Entry Resistance: All windows shall conform to ASTM F588, Grade 10.

13. Thermal Barrier Test: Thermal break shall be designed in accordance with AAMA TIR-A8 and tested in accordance with AAMA 505.

C. Environmental Product Declaration (EPD): Shall have a Type III Product-Specific EPD created from a Product Category Rule.

## 1.5 SUBMITTALS

A. Product Data: Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.

1. Recycled Content:

   a. Provide documentation that aluminum has a minimum of 50% mixed pre- and post-consumer recycled content with a sample document illustrating project specific information that will be provided after product shipment.
   b. Once product has shipped, provide project specific recycled content information, including:

      1) Indicate recycled content; indicate percentage of pre- and post-consumer recycled content per unit of product.
      2) Indicate relative dollar value of recycled content product to total dollar value of product included in project.

3) Indicate location recovery of recycled content.
4) Indicate location of manufacturing facility.

2. Environmental Product Declaration (EPD):

a. Include a Type III Product-Specific EPD created from a Product Category Rule.

B. Shop Drawings: Include plans, elevations, sections, details, hardware, and attachments to other work, operational clearances and installation details.

C. Samples for Initial Selection: For units with factory-applied color finishes including samples of hardware and accessories involving color selection.

D. Samples for Verification: For aluminum windows and components required.

E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for each type, class, grade, and size of aluminum window. Test results based on use of downsized test units will not be accepted.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An installer which has had successful experiences with installation of the same or similar units required for this project and other projects of similar size and scope.

B. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by inclusion of test reports, and calculations.

C. Source Limitations: Obtain aluminum windows through one source from a single manufacturer.

D. Product Options: Drawings indicate size, profiles, and dimensional requirements of aluminum windows and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements.” Do not modify size and dimensional requirements.

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup for type(s) of window(s) indicated, in location(s) shown on Drawings.

F. Pre-installation Conference: Conduct conference at Project Site to comply with requirements in Division 01 Section “Project Management and Coordination”.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of aluminum-framed storefront openings by field measurements before fabrication and indicate field measurements on Shop Drawings.

1.8 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.

1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by manufacturer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Basis-of-Design Product:

1. Kawneer Company Inc.
2. Kawneer Series AA™6600 Windows
3. Project-Out (Awning) and Fixed
4. 6" (152 mm) AA™6600 frame depth
5. 3-9/16" (90.4 mm) Project-In vent depth or 3-3/8" (85.7 mm) Project-Out vent depth.
6. AW-PG70-AP (Operable) and AW-PG70-FW (Fixed)

B. Subject to compliance with requirements, provide a comparable product by the following:

1. Manufacturer: (_____)
2. Series: (_____)
3. Profile dimension: 2" x 6"
4. Performance Grade: (_____)

C. Substitutions: Refer to Substitutions Section for procedures and submission requirements.

1. Pre-Contract (Bidding Period) Substitutions: Submit written requests ten (10) days prior to bid date.
2. Post-Contract (Construction Period) Substitutions: Submit written request in order to avoid storefront installation and construction delays.
3. Product Literature and Drawings: Submit product literature and drawings modified to suit specific project requirements and job conditions.
4. Certificates: Submit certificate(s) certifying substitute manufacturer (1) attesting to adherence to specification requirements for storefront system performance criteria, and (2) has been engaged in the design, manufacturer and fabrication of aluminum storefronts for a period of not less than ten (10) years. (Company Name)
5. Test Reports: Submit test reports verifying compliance with each test requirement required by the project.

6. Samples: Provide samples of typical product sections and finish samples in manufacturer's standard sizes.

D. Substitution Acceptance: Acceptance will be in written form, either as an addendum or modification, and documented by a formal change order signed by the Owner and Contractor.

## 2.2 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" (1.8) wall thickness at any location for the main frame and sash members.

1. Recycled Content: Shall have a minimum of 50% mixed pre- and post-consumer recycled content.

a. Indicate recycled content; indicate percentage of pre-consumer and post-consumer recycled content per unit of product
b. Indicate relative dollar value of recycled content product to total dollar value of product included in project.
c. Indicate location recovery of recycled content.
d. Indicate location of manufacturing facility.

B. Thermal Barrier: The thermal barrier shall be Kawneer consisting of two parallel glass fiber-reinforced nylon strips installed continuously and mechanically bonded to the aluminum.

C. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum members, trim hardware, anchors, and other components.

D. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

E. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

F. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

## 2.3 WINDOW FRAMING SYSTEM

A. Series AA™6600 Windows - Project-Out (Awning).

B. Series AA™6600 Windows - Fixed.

2.4 GLAZING SYSTEMS

A. Glass and Glazing Materials: Refer to Division 08 Section “Glazing” for glass units and glazing requirements applicable to glazed aluminum window units.

B. Glazing System: Glazing method shall be a dry type in accordance with manufacturer’s standards. Exterior glazing shall be TPE gasket. Interior glazing shall be snap-in type glazing beads with an interior TPE gasket in accordance with AAMA 702 or ASTM C864.

2.5 HARDWARE

A. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock aluminum windows, and sized to accommodate sash weight and dimensions.

B. Projected Window Typical Hardware:

1. Locking

a. Dual Handle Multi-Point Locks (Standard) Project-Out
b. Cast White Bronze Cam Locks (Project-Out)
c. Access Control Locks (Project-Out)

2. Hinging

a. 4-Bar Hinges (Standard)
b. Limit Stop

3. Other

a. Roto Operator (Project-Out)
b. Pole Ring
c. Pole

2.6 ACCESSORIES

A. Spacers, Setting Blocks, Gaskets, and Bond Breakers: Manufacturer's standard permanent, non-migrating types in hardness recommended by manufacturer, compatible with sealants, and suitable for system performance requirements.

B. Framing system gaskets, sealants, and joint fillers as recommended by manufacturer for joint type.

C. Sealants and joint fillers for joints at perimeter of window system as specified in Division 7 Section “Joint Sealants”.

D. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

E. Optional interior Trims: Extruded aluminum, 6063-T6 alloy and temper, extruded to profiles and details indicated.

1. Interior Trims: The interior face trim minimum wall thickness shall be 0.062". The face trim shall snap-fit onto concealed mounting clip. Exposed fasteners shall not be accepted. The mounting clip shall be extruded aluminum of 6063-T6 alloy and temper. The minimum wall thickness shall be 0.062". The trim clips shall be provided in 4" lengths and spaced a maximum of 18" center to center.

F. Coupling Mullions: Shall be extruded aluminum of 6063-T6 alloy and temper of profile and dimensions indicated on drawings. Mullions shall provide structural properties to resist wind pressure required by performance criteria and standards.

G. Insect Screens (Projecting Windows Only): Extruded aluminum frames, 6063-T6 alloy and temper, joined at corners: 18 x 16 mesh fiberglass screen cloth; frames finished to match aluminum windows; splines shall be extruded vinyl, removable to permit rescreening.

## 2.7 FABRICATION

A. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fit joints; make joints flush, hairline and weatherproof.
3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

B. Window Vent and/or Vent Frame Joinery: Mitered and Mechanically clipped and/or staked. Factory sealed vent and /or vent frame and corner joints.

C. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

D. Fabricate aluminum windows that are re-glazable without dismantling sash or framing.

E. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact. Thermal barriers shall be designed in accordance with AAMA TIR A8.

1. Thermal Barrier: The thermal barrier shall be Kawneer consisting of two parallel glass fiber-reinforced nylon strips installed continuously and mechanically bonded to the aluminum.

F. Glazing Stops: Provide snap-on glazing stops coordinated with Division 08 Section “Glazing” and glazing system indicated. Provide glazing stops to match frame

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Factory Finishing:
1. Kawneer Permanodic™ AA-M10C21A41 / AA-M45C22A41, AAMA 611, Architectural Class I Clear Anodic Coating (Color #14 Clear) (Optional).

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weather tight window installation.
1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
2. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing aluminum-framed storefront system, accessories, and other components.

B. Install aluminum-framed storefront system level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weather tight construction.

D. Install aluminum-framed storefront system and components to drain condensation, water penetrating joints, and moisture migrating within aluminum-framed storefront system to the exterior.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

## 3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows shall take place as follows:

1. Testing Methodology: Testing Standard shall be per AAMA 502 including reference to ASTM E 783 for Air Infiltration Test and ASTM E 1105 for Water Penetration Test.

a. Air Infiltration Test: Conduct test in accordance with ASTM E 783 at a minimum uniform static test pressure of 1.57 psf for CW or 6.24 psf for AW. The maximum allowable rates of air leakage for field testing shall not exceed 1.5 times the project specifications.
b. Water Infiltration Test: Water penetration resistance tests shall be conducted in accordance with ASTM E 1105 at a static test pressure equal to 2/3 the specified water test pressure.

2. Testing Extent: Architect shall select window units to be tested as soon as a representative portion of the project has been installed, glazed, perimeter caulked and cured. Conduct tests for air infiltration and water penetration with manufacturer's representative present.
3. Test Reports: Shall be prepared according to AAMA 502.

## 3.4 ADJUSTING, CLEANING AND PROTECTION

A. Adjust operating sashes, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weather tight closure. Lubricate hardware and moving parts.

B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

C. Clean glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.

D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

E. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

**END OF SECTION**

**SECTION 08 71 00**

**DOOR HARDWARE**

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.02 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware for:

    a. Swinging doors.
    b. Sliding doors.

2. Field verification, preparation and modification of existing doors and frames to receive new door hardware.
3. Lead-lining door hardware items required for radiation protection at door openings.
4. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.

B. Exclusions: Unless specifically listed in hardware sets, hardware is not specified in this section for:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
2. Division 09 sections for touchup, finishing or refinishing of existing openings modified by this section.

1.03 REFERENCES

A. UL - Underwriters Laboratories

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Key Systems and Nomenclature

C. ANSI - American National Standards Institute

1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties

1.04 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 requirements.
2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, “EXAMINATION” article, herein.

B. Action Submittals:

1. Product Data: Technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Samples for Verification: If requested by Architect, submit production sample or sample installations of each type of exposed hardware unit in finish indicated, and tagged with full description for coordination with schedule.

    a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.

3. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:

a. Door Index; include door number, heading number, and Architects hardware set number.
b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
c. Quantity, type, style, function, size, and finish of each hardware item.
d. Name and manufacturer of each item.
e. Fastenings and other pertinent information.
f. Location of each hardware set cross-referenced to indications on Drawings.
g. Explanation of all abbreviations, symbols, and codes contained in schedule.
h. Mounting locations for hardware.
i. Door and frame sizes and materials.
j. Name and phone number for local manufacturer's representative for each product.
k. Operational Description of openings with any electrified hardware (locks, exits, electromagnetic locks, electric strikes, automatic operators, door position switches, magnetic holders or closer/holder units, and access control components). Operational description should include operational descriptions for: egress, ingress (access), and fire/smoke alarm connections.
    1) Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work that is critical in Project construction schedule.

4. Key Schedule:

    a. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
    b. Use ANSI/BHMA A156.28 “Recommended Practices for Keying Systems” as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
    c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
    d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
    e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
        1) Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.

    f. Prepare key schedule by or under supervision of supplier, detailing Owner’s final keying instructions for locks.

5. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory or shop prepared for door hardware installation.

C. Informational Submittals:

1. Qualification Data: For Supplier, Installer and Architectural Hardware Consultant.

2. Product data for electrified door hardware:

    a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

3. Certificates of Compliance:

    a. UL listings for fire-rated hardware and installation instructions if requested by Architect or Authority Having Jurisdiction.
    b. Installer Training Meeting Certification: Letter of compliance, signed by Contractor, attesting to completion of installer training meeting specified in "QUALITY ASSURANCE" article, herein.
    c. Electrified Hardware Coordination Conference Certification: Letter of compliance, signed by Contractor, attesting to completion of electrified hardware coordination conference, specified in "QUALITY ASSURANCE" article, herein.

4. Warranty: Special warranty specified in this Section.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:

    a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
    b. Catalog pages for each product.
    c. Factory order acknowledgement numbers (for warranty and service)
    d. Name, address, and phone number of local representative for each manufacturer.
    e. Parts list for each product.
    f. Final approved hardware schedule, edited to reflect conditions as-installed.
    g. Final keying schedule
    h. Copies of floor plans with keying nomenclature
    i. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
    j. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

## 1.05 QUALITY ASSURANCE

A. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

4. Coordination Responsibility: Assist in coordinating installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.

    a. Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.

B. Architectural Hardware Consultant Qualifications: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:

1. For door hardware, DHI-certified, Architectural Hardware Consultant (AHC).
2. Can provide installation and technical data to Architect and other related subcontractors.
3. Can inspect and verify components are in working order upon completion of installation.
4. Capable of producing wiring diagrams.
5. Capable of coordinating installation of electrified hardware with Architect and electrical engineers.

C. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

D. Fire-Rated Door Openings: Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.

E. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.

F. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in “REFERENCES” article, herein.

G. Keying Conference

1. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:

    a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
    b. Preliminary key system schematic diagram.
    c. Requirements for key control system.
    d. Requirements for access control.
    e. Address for delivery of keys.

H. Pre-installation Conference

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

2. Inspect and discuss preparatory work performed by other trades.
3. Inspect and discuss electrical roughing-in for electrified door hardware.
4. Review sequence of operation for each type of electrified door hardware.
5. Review required testing, inspecting, and certifying procedures.

I. Coordination Conferences:

1. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.
2. Electrified Hardware Coordination Conference: Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1. Deliver each article of hardware in manufacturer's original packaging.

C. Project Conditions:

1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
2. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.

D. Protection and Damage:

1. Promptly replace products damaged during shipping.
2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.
3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.

E. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

F. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

## 1.07 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

E. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

1.08 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Beginning from date of Substantial Completion, for durations indicated.

a. Closers:
1) Mechanical: 10 years.

b. Exit Devices:
1) Mechanical: 3 years.

c. Locksets:
1) Mechanical: 10 years.

d. Continuous Hinges: Lifetime warranty.
e. Key Blanks: Lifetime

2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

1.09 MAINTENANCE

A. Maintenance Tools: Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

**PART 2 - PRODUCTS**

2.01 MANUFACTURERS

A. Approval of manufacturers and/or products other than those listed as “Scheduled Manufacturer” in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.

B. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

A. Fasteners

1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receivepainted finish.
3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
4. Install hardware with fasteners provided by hardware manufacturer.

B. Modification and Preparation of Existing Doors: Where existing door hardware is indicated to be removed and reinstalled.

1. Provide necessary fillers, Dutchmen, reinforcements, and fasteners, compatible with existing materials, as required for mounting new opening hardware and to cover existing door and frame preparations.
2. Use materials which match materials of adjacent modified areas.
3. When modifying existing fire-rated openings, provide materials permitted by NFPA 80 as required to maintain fire-rating.

C. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.03 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Ives 5BB series.

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:

   a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
   b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high

3. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:

   a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high

4. 2 inches or thicker doors:

   a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
   b. Interior: Heavy weight, steel, 5 inches (127 mm) high

5. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
6. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
7. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:

   a. Steel Hinges: Steel pins
   b. Non-Ferrous Hinges: Stainless steel pins
   c. Out-Swinging Exterior Doors: Non-removable pins
   d. Out-Swinging Interior Lockable Doors: Non-removable pins
   e. Interior Non-lockable Doors: Non-rising pins

8. Width of hinges: 4-1/2 inches (114 mm) at 1-3/4 inch (44 mm) thick doors, and 5 inches (127 mm) at 2 inches (51 mm) or thicker doors. Adjust hinge width as required for door, frame, and wall conditions to allow proper degree of opening.

## 2.04 CONTINUOUS HINGES

A. Aluminum Geared

1. Manufacturers:

   a. Scheduled Manufacturer: Ives.

2. Requirements:

   a. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
   b. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.

c. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
d. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
e. On fire-rated doors, provide aluminum geared continuous hinges that are classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
f. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware.
g. Install hinges with fasteners supplied by manufacturer.
h. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

## 2.05 FLUSH BOLTS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Requirements:

1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

## 2.06 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Falcon T series.

B. Requirements:

1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3 hour fire doors.
2. Cylinders: Refer to “KEYING” article, herein.
3. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw. Provide proper latch throw for UL listing at pairs.
4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
7. Provide electrified options as scheduled in the hardware sets.
8. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.

a. Lever Design: Falcon Latitude.

## 2.07 EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Falcon 24/25 series.

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of doorhardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide flush end caps for exit devices.
7. Provide exit devices with manufacturer's approved strikes.
8. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
9. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass beadkits.
10. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
11. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

## 2.08 MAGNETIC LOCKS

A. Magnetic Locks – Surface Type:

1. Manufacturers and Products:

a. Scheduled Manufacturer and Product: Schlage M490 series.

2. Requirements:

a. Provide magnetic locks certified to meet ANSI/BHMA A156.23 classification criteria including minimum holding force of 1500 LBF. Provide magnetic locks equipped with SPDT Magnetic Bond Sensing device, where specified, to monitor whether sufficient magnetic holding force exists to ensure adequate locking and SPDT Door Status Monitor device, where specified, to monitor whether door is open or closed. Provide bond sensors fully concealed within electromagnet to resist tampering or damage.
b. Provide magnetic locks certified to meet UL10C, and UL1034 forburglary-resistant electronic locking mechanisms.

c. Provide fasteners, mounting brackets, and spacer bars required for mounting and details.
d. Provide power supply recommended and approved by manufacturer of magnetic locks.
e. Where magnetic locks are scheduled, provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of magnetic locks for each individual leaf. Switches control both doors simultaneously at pairs. Locate controls as directed by Architect.

## 2.09 PASSIVE INFRARED MOTION SENSORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Schlage SCAN II Series.

## 2.10 POWER SUPPLIES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Schlage/Von Duprin PS900 series.

B. Requirements:

1. Provide power supplies approved by manufacturer of supplied electrified hardware.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
4. Provide power supplies with the following features:

a. 12/24 VDC Output, field selectable.
b. Class 2 Rated power limited output.
c. Universal 120-240 VAC input.
d. Low voltage DC, regulated and filtered.
e. Polarized connector for distribution boards.
f. Fused primary input.
g. AC input and DC output monitoring circuit w/LED indicators.
h. Cover mounted AC Input indication.
i. Tested and certified to meet UL294.
j. NEMA 1 enclosure.
k. Hinged cover w/lock down screws.
l. High voltage protective cover.

2.11 KEYING

A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

C. Requirements:

1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.

    a. Master Keying system as directed by the Owner.

2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
3. Provide keys with the following features:

    a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)

4. Identification:

    a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication “Keying Systems and Nomenclature” for identification. Do not provide blind code marks with actual key cuts.
    b. Identification stamping provisions must be approved by the Architect and Owner.
    c. Stamp cylinders/cores and keys with Owner’s unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with “DO NOT DUPLICATE” along with the “PATENTED” or patent number to enforce the patent protection.
    d. Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
    e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.

5. Quantity: Furnish in the following quantities.

    a. Change (Day) Keys: 3 per cylinder/core.
    b. Permanent Control Keys: 3.
    c. Master Keys: 6.

2.12 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Falcon SC70A series.

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
3. Closer Body: 1-1/2 inch (38 mm) diameter with 5/8 inch (16 mm) diameter heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

## 2.13 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Falcon SC80A series.

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory.
2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
3. Closer Body: 1-1/4 inch (32 mm) diameter, with 5/8 inch (16 mm) diameter heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

## 2.14 ELECTRO-MECHANICAL AUTOMATIC OPERATORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: TORMAX iMotion

2. The operator shall be capable of swinging interior or exterior doors weighing up to 1000 pounds (454 kg). The system shall consist of a non-handed electro-mechanical power open spring close swing door operator with heavy duty mechanics, galvanized floor box, self-learning iMotion® microprocessor programmable controller, door connecting hardware, seven-segmented function control panel and operate controls, safety controls and guide rails to meet ANSI Standard. The use of a mechanical converter to support the door and an overhead commercial/pedestrian rated overhead swing door operator to power the door open and close shall not be permitted. The use of mechanical switches and or cams to determine door position shall not be permitted. Provide units with manual off/auto/hold-open switch, push and go function to activate power operator, vestibule interface delay, electric lock delay, hold-open delay adjustable from 2 to 30 seconds, and logic terminal to interface with accessories, mats, and sensors.
3. Power Open Operation: Low Energy Power Operated Door. The operator shall open the door with a 1/3 HP AC Synchronous wear free motor driving a transmission assembly that is coupled with the remote self-learning iMotion microprocessor programmable controller. The AC motor shall have a built-in protection circuit that interrupts current to the motor if the door is blocked open. The drive train shall have positive, constant engagement. Operator shall stop the door in the open position and shall stall against an internal adjustable end stop. The door shall remain in the full open position as required by ANSI Standard.
4. Spring Closing Operation: The operator shall close the door by spring energy. Closing speed shall be controlled by employing the motor as a dynamic break. Operator shall stop the door in the closed position and stall against an internal adjustable end stop. Closing spring shall be pre-loaded for positive closing action at a low material stress level. Door closing speed as required by ANSI Standard. Provide weather-resistant actuators at exterior applications.
5. Manual Operation: Operator shall function as a manual door closer in the direction of swing with or without electric power.
6. Floor Box: Flush Mount Box Surface box shall be supplied with satin stainless steel cover and will accommodate threshold applications up to 1/2” (13) in profile height. Flush box shall be supplied with pan type cover for floor covering up to 3/4” (19) maximum. Note: a weep drain shall be provided by contractor to eliminate any fluids from building up inside the box
7. Door Pivots: Commercial Grade Door Offset Pivots for slender bottom door rails or patch rail systems. Commercial grade door pivots for doors with slender bottom door rails and/or patch fittings with shallow web depth. A commercial grade door pivot shall be splined to the operator drive spindle for maximum holding and strength. The door pivot shall provide positive control of door through entire swing.

## 2.15 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Requirements:

1. Provide decorative pulls as scheduled. Where required, mount back to back with pull.

## 2.16 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Requirements:

1. Provide kick plates, mop plates, and armor plates minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes of plates:

   a. Kick Plates: 10 inches (254 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
   b. Mop Plates: 4 inches (102 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs
   c. Armor Plates: 36 inches (914 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs

## 2.17 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers: Glynn-Johnson.

B. Requirements:

1. Provide heavy duty concealed mounted overhead stop or holder as specified for exterior and interior vestibule single acting doors.
2. Provide heavy duty concealed mounted overhead stop or holder as specified for double acting doors.
3. Provide heavy or medium duty and concealed or surface mounted overhead stop or holder for interior doors as specified. Provide medium duty surface mounted overhead stop for interior doors and at any door that swings more than 140 degrees before striking wall, open against equipment, casework, sidelights, and where conditions do not allow wall stop or floor stop presents tripping hazard.
4. Where overhead holders are specified provide friction type at doors without closer and positive type at doors with closer.

## 2.18 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.

## 2.19 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer: Zero International.

B. Requirements:

1. Provide thresholds, weather-stripping (including door sweeps, seals, and astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Size of thresholds:

   a. Saddle Thresholds: 1/2 inch (13 mm) high by jamb width by door width
   b. Bumper Seal Thresholds: 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width

4. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

## 2.20 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

## 2.21 BARN DOOR HARDWARE

A. Manufacturers:

1. Scheduled Manufacturer: KN Crowder.

B. Requirements:

1. Provide complete sets of sliding door hardware as recommended by manufacturer for door type and weight.

a. Include track, channels, brackets, hangers, fasteners, guides, pulls, stops, and other hardware as required for complete installation.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.

C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.

C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.

D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.

G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

H. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as indicated in keying section.
2. Furnish permanent cores to Owner for installation.

I. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

J. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.

K. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.

L. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

M. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.

N. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

O. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

## 3.03 FIELD QUALITY CONTROL

A. Engage qualified manufacturer trained representative to perform inspections and to prepare inspection reports.

1. Representative will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

## 3.04 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to

operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, Installer's Architectural Hardware Consultant must examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.05 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.06 DOOR HARDWARE SCHEDULE

A. Hardware items are referenced in the following hardware. Refer to the above-specifications for special features, options, cylinders/keying, and other requirements.

B. Hardware Sets:

**Hardware Group No. 01**

121

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | 652 | IVE |
| 1 | EA | OFFICE LOCK | T501HD7 LAT | 626 | FAL |
| 1 | EA | SFIC CORE | C607 | 626 | FAL |
| 1 | EA | SURFACE CLOSER | SC81A RW/PA FC | 689 | FAL |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | 630 | IVE |
| 1 | EA | GASKETING | 488S-BK (OMIT @ NON RATED OPENINGS USE SILENCERS) | BK | ZER |

**Hardware Group No. 02**

010B

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 6 | EA | HINGE | 5BB1HW 4.5 X 4.5 NRP | 652 | IVE |
| 1 | SET | CONST LATCHING BOLT | FB52 | 630 | IVE |
| 1 | EA | FIRE EXIT HARDWARE | F-25-M-L-NL-LAT | 626 | FAL |
| 1 | EA | MORTISE CYLINDER | C987-7CCA | 626 | FAL |
| 1 | EA | SFIC CORE | C607 | 626 | FAL |
| 1 | EA | COORDINATOR | COR X FL | 628 | IVE |
| 2 | EA | MOUNTING BRACKET | MB1F | 689 | IVE |
| 2 | EA | SURFACE CLOSER | SC81A SS FC | 689 | FAL |
| 2 | EA | KICK PLATE | 8400 10" X 1" LDW B-CS | 630 | IVE |
| 1 | SET | GASKETING | 328AA-S | AA | ZER |
| 1 | EA | ASTRAGAL | OVERLAPPING DOOR ASTRAGAL BY DOOR MANUFACTURER | | B/O |

**Hardware Group No. 03**

122B

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1HW 5 X 4.5 NRP | 630 | IVE |
| 1 | EA | STOREROOM LOCK | T581HD7 LAT | 626 | FAL |
| 1 | EA | SFIC CORE | C607 | 626 | FAL |
| 1 | EA | SURFACE CLOSER | SC71A SS | 689 | FAL |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | 630 | IVE |
| 1 | EA | RAIN DRIP | 142AA DW + 4" | AA | ZER |
| 1 | SET | GASKETING | 328AA-S | AA | ZER |
| 1 | EA | DOOR SWEEP | 39A | A | ZER |
| 1 | EA | THRESHOLD | 625A-226 | A | ZER |

**Hardware Group No. 04**

122A

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 6 | EA | HINGE | 5BB1HW 4.5 X 4.5 NRP | 630 | IVE |
| 1 | SET | CONST LATCHING BOLT | FB51P | 630 | IVE |
| 1 | EA | STOREROOM LOCK | T581HD7 LAT | 626 | FAL |
| 1 | EA | SFIC CORE | C607 | 626 | FAL |
| 1 | EA | OH STOP & HOLDER | 90H | 630 | GLY |
| 1 | EA | SURFACE CLOSER | SC71A SSHO | 689 | FAL |
| 2 | EA | KICK PLATE | 8400 10" X 1" LDW B-CS | 630 | IVE |
| 1 | EA | RAIN DRIP | 142AA DW + 4" | AA | ZER |
| 1 | SET | GASKETING | 328AA-S | AA | ZER |
| 1 | EA | ASTRAGAL | OVERLAPPING DOOR ASTRAGAL BY DOOR MANUFACTURER | | B/O |
| 2 | EA | DOOR SWEEP | 39A | A | ZER |
| 1 | EA | THRESHOLD | 625A-226 | A | ZER |

**Hardware Group No. 05**

102

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 6 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | 652 | IVE |
| 1 | SET | CONST LATCHING BOLT | FB52 | 630 | IVE |
| 1 | EA | CLASSROOM LOCK | T561HD7 LAT | 626 | FAL |
| 1 | EA | SFIC CORE | C607 | 626 | FAL |
| 1 | EA | COORDINATOR | COR X FL | 628 | IVE |
| 2 | EA | MOUNTING BRACKET | MB1F | 689 | IVE |
| 2 | EA | SURFACE CLOSER | SC81A RW/PA FC | 689 | FAL |
| 2 | EA | KICK PLATE | 8400 10" X 1" LDW B-CS | 630 | IVE |
| 2 | EA | WALL STOP | WS406/407CCV | 630 | IVE |
| 1 | EA | GASKETING | 488S-BK (OMIT @ NON RATED OPENINGS USE SILENCERS) | BK | ZER |
| 1 | EA | ASTRAGAL | OVERLAPPING DOOR ASTRAGAL BY DOOR MANUFACTURER | | B/O |

**Hardware Group No. 06**

109

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 | 652 | IVE |
| 1 | EA | CLASSROOM LOCK | T561HD7 LAT | 626 | FAL |
| 1 | EA | SFIC CORE | C607 | 626 | FAL |
| 1 | EA | SURFACE CLOSER | SC81A RW/PA FC | 689 | FAL |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | 630 | IVE |
| 1 | EA | GASKETING | 488S-BK (OMIT @ NON RATED OPENINGS USE SILENCERS) | BK | ZER |

**Hardware Group No. 07**

010A

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1HW 4.5 X 4.5 NRP | 652 | IVE |
| 1 | EA | FIRE EXIT HARDWARE | F-25-R-L-NL-LAT | 626 | FAL |
| 1 | EA | MORTISE CYLINDER | C987-7CCA | 626 | FAL |
| 1 | EA | SFIC CORE | C607 | 626 | FAL |
| 1 | EA | SURFACE CLOSER | SC81A RW/PA FC | 689 | FAL |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CCV | 630 | IVE |
| 1 | EA | GASKETING | 488S-BK (OMIT @ NON RATED OPENINGS USE SILENCERS) | BK | ZER |

**Hardware Group No. 08**

100

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 2 | EA | LONG DOOR PULL | PR 9264F 36" N | 630-316 | IVE |
| 2 | EA | IN FLOOR AUTO OPERATOR | TN 110 W/ OFFSET OPERATOR ARM AND TOP PIVOT | | TOR |
| 1 | EA | ACTUATOR, JAMB MOUNT | 8310-3818TWF | 630 | LCN |
| 1 | EA | ACTUATOR KIT | 8310-3856TWF | 630 | LCN |
| 1 | EA | RECEIVER | 8310-865 | | LCN |
| 1 | EA | BOLLARD POST | 8310-866 | AL | LCN |
| 1 | SET | SEAL | PERIMETER SEAL BY FRAME MANUFACTURER | | |
| 1 | SET | ASTRAGAL | MEETING STILE SEAL BY DOOR MANUFACTURER | | |
| 2 | EA | DOOR SWEEP | 39A | A | ZER |
| 1 | EA | THRESHOLD | 625A-226 | A | ZER |

**Hardware Group No. 09**

101

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 1 | EA | INTERFACE BOX | JB7 | | VON |
| 1 | EA | MORTISE CYLINDER | C987-7CCA | 626 | FAL |
| 1 | EA | SFIC CORE | C607 | 626 | FAL |
| 1 | EA | MAGNETIC LOCK | M492P ATS/LED-2 12/24 VDC | 628 | SCE |
| 2 | EA | LONG DOOR PULL | PR 9264F 36" N | 630-316 | IVE |
| 2 | EA | IN FLOOR AUTO OPERATOR | TN 110 W/ OFFSET OPERATOR ARM AND TOP PIVOT | | TOR |
| 2 | EA | ACTUATOR KIT | 8310-3856TWF | 630 | LCN |
| 1 | EA | ACTIVATION RECEIVER | 8310-865 | 630 | LCN |
| 1 | EA | INTERCOM | INTERCOM BY OTHERS | | B/O |
| 1 | SET | SEAL | PERIMETER SEAL BY FRAME MANUFACTURER | | |
| 1 | SET | ASTRAGAL | MEETING STILE SEAL BY DOOR MANUFACTURER | | |
| 1 | EA | MULTITECH READER | *MT15 FURNISHED, INSTALLED & COMMISSIONED BY DIV 28 | BLK | SCE |
| 1 | EA | PUSH BUTTON | 625RDEX DA 12/24 VDC | 630 | SCE |
| 1 | EA | KEY SWITCH | 653-14 L2 12/24 VDC | 630 | SCE |
| 1 | EA | MOTION SENSOR | SCANII 12/24 VDC | BLK | SCE |
| 1 | EA | POWER SUPPLY | PS902 FA900 120/240 VAC | LGR | SCE |

- INGRESS BY VALID CREDENTIAL, INTERCOM REMOTE RELEASE OR KEY OVERRIDE.
- ALWAYS FREE EGRESS.
- PRESENTING A VALID CREDENTIAL WILL ACTIVATE THE ACTUATOR.
- INSIDE ACTUATOR ALWAYS ACTIVE.
- PRESSING THE ACTUATOR WILL BEGIN A SEQUENCE FIRST RELEASING THE MAG LOCK, THEN THE OPERATOR WILL BEGIN TO SWING THE DOOR.
- MAG LOCK WILL FAIL SAFE WITH SIGNAL FROM FIRE ALARM.
- OPERATING THE KEY SWITCH WILL TURN OFF THE MAG LOCK AND ENERGIZE THE OUTSIDE ACTUATOR TO ALLOW FREE INGRESS.

**Hardware Group No. 10**

103

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 1 | EA | TOP PATCH FITTING | PH21ABS | 630 | CRL |
| 1 | EA | LONG DOOR PULL | PR 9266F 36" P | 630-316 | IVE |
| 1 | EA | HYDRAULIC PATCH FITTING CLOSER | CRL380BS | 630 | CRL |
| 1 | EA | FLOOR STOP | FS410 | 626 | IVE |
| | | | REMAINDER OF HARDWARE BY GLASS DOOR MANUFACTURER | | |

END OF SECTION

Vivian Gordon Harsh Apartments Renovation

| Door Numbers | HwSet# |
|---|---|
| 010A | 07 |
| 010B | 02 |
| 100 | 08 |
| 101 | 09 |
| 102 | 05 |
| 103 | 10 |
| 109 | 06 |
| 121 | 01 |
| 122A | 04 |
| 122B | 03 |
| R001 | |

**SECTION 08 80 00**

**GLAZING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows
2. Doors
3. Glazed entrances

B. Related Sections:
1. Section 01 33 23: Shop Drawings, Product Data and Samples.
2. Section 08 11 13: Hollow Metal Doors and Frames.
3. Section 08 14 16: Flush Wood Doors
4. Section 08 41 13: Aluminum-Framed Entrances and Storefronts.
5. Section 08 44 13: Glazed Aluminum Curtain Walls
6. Section 08 71 00: Door Hardware

### 1.3 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glass Samples: For each type of 12 inches square.

1. Insulating Glass
2. Interior Glass
3. Fire-resistive glazing products

### 1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved **and certified** by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

D. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.

## 1.5 DELIVERY, STORAGE AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

## 1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

## 1.7 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: **10** years from date of Substantial Completion.

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: **10** years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GLASS PRODUCTS

A. Thickness: Min. 1" glass thickness unless otherwise noted on the drawings. Provide glass lites in thicknesses as needed to comply with requirements indicated.

B. Float Glass: ASTM C 1036, Type I, Quality-q3, Class I (clear), free of visible tong marks, unless otherwise indicated

C. Tempered

### 2.2 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
2. Warm Spacer: Manufacturer's standard spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or blend of both.

B. Subject to compliance with requirements, provide glazing by one of the following:

1. PPG – Solarban 60 – Low E on #3 surface, 90% argon filled (Basis of Design)
2. Cardinal – Low-E2 270 and Low-E366
3. Viracon – VE 1-2M and VNE 15-36

### 2.3 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from **one of** the following:

1. Neoprene complying with ASTM C 864.
2. EPDM complying with ASTM C 864.
3. Silicone complying with ASTM C 1115.
4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned **neoprene** gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.

1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

## 2.4 GLAZING SEALANTS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
5. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

## 2.5 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.7 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

## 3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

## 3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to

produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.8 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

**END OF SECTION**

**SECTION 08 88 10**

**FIRE-RATED GLASS AND FRAMING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes: Fire-rated glazing

1. Basis-of-Design: SuperClear 45-HS-LI fire protective, safety rated, low-iron clear glazing material.
2. Applications of fire rated glazing include:
   a. Fire rated glazing as vision lites in door assemblies.
   b. Fire rated glazing as sidelites, windows or transoms in fire rated frames.

B. Related Sections:

1. Section 01 33 23: Shop Drawings, Product Data and Samples.
2. Section 06 40 00: Architectural Woodwork.
3. Section 08 11 13: Hollow Metal Doors and Frames.
4. Section 08 14 16: Flush Wood Doors.
5. Section 08 80 00: Glazing.

### 1.3 REFERENCES

A. National Fire Protection Association (NFPA):

1. NFPA 80: Fire Doors and Windows.
2. NFPA 252: Fire Tests of Door Assemblies.
3. NFPA 257: Fire Tests of Window Assemblies.

B. Underwriters Laboratories, Inc. (UL):

1. UL 9: Standard for Safety of Fire Tests of Window Assemblies.
2. UL 10 B: Standard for Safety of Fire Tests of Door Assemblies.
3. UL 10 C: Standard for Safety of Positive Pressure Tests of Door Assemblies.

C. Consumer Product Safety Commission (CPSC):

1. CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials

D. ANSI – American National Standards Institute

1. ANSI Z91.1: Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test.

E. Glass Association of North America (GANA)

1. GANA – Glazing Manual.
2. FGMA – Sealant Manual.

F. Chicago Building Code, 2019 Edition

1.4 SYSTEM DESCRIPTION

A. Performance Requirements: Provide a fire rating glazing manufactured, fabricated and installed to maintain performance criteria stated by manufacturer without defects, damage or failure.

1. Fire Rating: 45 minutes with hose stream.
2. Fire protective, safety rated clear glazing tested in accordance with NFPA 80, NFPA 252, NFPA 257, UL 9, UL 10B, UL 10C, CAN/ULC S104 and CAN/ULCS106.
3. Safety Rating: CPSC 16 CFR 1201 Category I and II, ANSI Z79.1 Class A and B and CGSB 12.1 Class A and B.
4. Maximum Sizes: Maximum clear view area for non-temperature rise 45 minute doors is 3,288 sq. in. (33 in width x 99-5/8 in. height). Maximum clear view area for 45 minute sidelites, openings and transoms when ASTM E-119/UL 263/ULC-S101 is not required is 3,880 sq. in. (96 in. width or height).
5. Testing Laboratory: Fire test shall be conducted by a nationally recognized independent testing laboratory.

B. Listings and Labels:

1. Fire rated glazing shall be under current follow-up service by a nationally recognized independent testing laboratory approved by OSHA and maintain a current listing or certification. Assemblies shall be labeled in accordance with limits of listings.

1.5 SUBMITTALS

A. Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedure Section.

1. Shop Drawings: Submit shop drawings showing layout, profiles and product components.
2. Samples: Submit 12 x 12 glass samples.
3. Technical Information: Submit latest edition of manufacturer’s product data.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1 Product Requirements Sections.

B. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials to specified destinations in manufacturer's or distributor's packaging undamaged, complete with installation instructions.

D. Storage and Protection: Store off ground, under cover, protected from weather and construction activities and at temperature conditions recommended by manufacturer.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual measurements for openings by field measurements before fabrication. Show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.8 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document. Manufacturer's warranty is not intended to limit other rights that the Owner may have under the Contract Documents.

1. Warranty Period: Lifetime warranty.

**PART 2 - PRODUCTS**

2.1 FIRE RATED GLAZING

A. Material: SuperClear 45-HS-LI 45 minute fire and safety rated glazing.

B. Manufacturer: SuperClear 45-HS-LI ¾" thick low-iron special fire protective glazing as manufactured and distributed by SAFTI*FIRST*.

1. Contact: 100 N Hill Drive, Suite 12, Brisbane, CA 94005; Telephone 888.653.3333; Fax 888.653.4444; email info@safti.com; Web site www.safti.com
2. Must be provided by a US manufacturer. Distributors of fire rated glass are not to be considered as manufacturers.

C. Design Requirements:

1. Thickness: ¾" (19 mm) standard.
2. Weight: 9 lbs./sq. ft.
3. Sound Transmission Rating: Must meet 37 STC/35 OITC in standard hollow metal frames. Glass and frame must be tested as an assembly. Glass only STC/OITC values are not acceptable.
4. Appearance: clear, wireless and tint-free.
5. Visual Light Transmission: Must meet 90% VLT for low-iron.

6. Fire Rating: 45 minutes with hose stream.
7. Impact Safety Resistance: Must meet CPSC 16 CFR 1201 Category I and II, ANSI Z91.1 Class A and B and CAN/CGSB 12.1 Class A and B.
8. Customizations: Available in insulated and energy performance make-ups.

D. Manufacturer's Fire Rated Glazing Material:

1. Each piece of fire-rated glazing material shall be labeled with a permanent logo including name of product, manufacturer, testing laboratory, fire rating period and safety glazing standards.
2. Glazing material installed in Hazardous Locations, subject to human impact, shall be certified and permanently labeled as meeting applicable requirements referenced in NFPA 80:

   a. CPSC 16 CFR 1201, Cat. I or II

2.2 MATERIALS

A. Glazing Accessories: Manufacturer recommended fire rated glazing accessory as follows:

1. Glazing tape: closed cell PVC foam tape or neoprene tape.
2. Setting blocks: calcium silicate or hardwood.
3. Cleaners, primers, sealers: type recommended by manufacturer of glass and gaskets.

2.3 RELATED PRODUCTS

A. Fire-Rated Window Frames:

1. Basis-of-Design: GPX™ Framing as manufactured by SAFTI *FIRST*™

B. Glazing shall be installed in an equally rated framing system.

2.4 SOURCE QUALITY

A. Obtain fire rated glazing products from a single manufacturer.

B. Fabrication Dimensions: Fabricate to approved dimensions. The general contractor shall guarantee dimensions where practicable within required tolerances

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions, have been previously installed under other sections, and are acceptable for product installation in accordance with manufacturer's instructions.

3.2 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data including product technical bulletins and installation instructions

3.3 INSTALLATION

A. Installation shall be in strict accordance with the fire glazing material manufacturer's specifications. Field cutting or tampering is strictly prohibited.

3.4 CLEANING AND PROTECTION

A. Protect glass from contact with contaminating substances resulting from construction operations. Remove such substances by method approved by manufacturer.

B. Wash glass on both faces not more than four days prior to date schedule for inspections intended to establish date of Substantial Completion. Wash glass by method recommended by glass manufacture.

C. Remove temporary coverings and protection of adjacent work areas.

D. Remove construction debris from project site and legally dispose of debris.

**END OF SECTION**

**SECTION 09 05 61**

**COMMON WORK RESULTS FOR FLOORING PREPARATION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. This section applies to all floors identified in the Contract Documents as to receive the following types of floor coverings:

    a. Ceramic tile
    b. Resilient tile and sheet
    c. Carpet

2. Removal of existing floor covering.
3. Preparation of new and existing concrete floor slabs for installation of floor coverings.
4. Testing of concrete floor slabs for moisture and alkalinity (pH).
5. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
6. Patching compound.
7. Remedial floor coatings.

### 1.3 RELATED REQUIREMENTS

A. Section 01 4000 - Quality Requirements: Additional requirements relating to testing agencies and testing.

### 1.4 REFERENCE STANDARDS

A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2016a.

B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete; 1999 (Reapproved 2014).

C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2017.

D. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2016a.

E. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2017.

F. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; 2011.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.6 SUBMITTALS

A. Visual Observation Report: For existing floor coverings to be removed.

B. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:

1. Moisture and alkalinity (pH) limits and test methods.
2. Manufacturer's required bond/compatibility test procedure.

C. Testing Agency's Report:

1. Description of areas tested; include floor plans and photographs if helpful.
2. Summary of conditions encountered.
3. Moisture and alkalinity (pH) test reports.
4. Copies of specified test methods.
5. Recommendations for remediation of unsatisfactory surfaces.
6. Submit report to Architect.
7. Submit report not more than two business days after conclusion of testing.

D. Adhesive Bond and Compatibility Test Report.

E. Copy of RFCI (RWP).

F. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.

1. Manufacturer's qualification statement.
2. Manufacturer's statement of compatibility with types of flooring applied over remedial product.
3. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.
4. Manufacturer's installation instructions.
5. Specimen Warranty: Copy of warranty to be issued by coating manufacturer and certificate of underwriter's coverage of warranty.

1.7 QUALITY ASSURANCE

A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.

B. Contractor may perform adhesive and bond test with his own personnel or hire a testing agency.

C. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.

1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.

D. Contractor's Responsibility Relating to Independent Agency Testing:

1. Provide access for and cooperate with testing agency.
2. Confirm date of start of testing at least 10 days prior to actual start.
3. Allow at least 4 business days on site for testing agency activities.
4. Achieve and maintain specified ambient conditions.
5. Notify Architect when specified ambient conditions have been achieved and when testing will start.

E. Remedial Coating Installer Qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer, and able to provide at least 3 project references showing at least 3 years' experience installing moisture emission coatings.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect products in accordance with manufacturer’s instructions and recommendations.

B. Deliver materials in manufacturer’s packaging; include installation instructions.

C. Keep materials from freezing.

1.9 FIELD CONDITIONS

A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.

B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

## PART 2 - PRODUCTS

2.1 MATERIALS

A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:

1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
2. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.

B. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.

1. Thickness: As required for application and in accordance with manufacturer's installation instructions.
2. Products:

a. ARDEX Engineered Cements; ARDEX MC RAPID: www.ardexamericas.com.
b. Floor Seal Technology, Inc; MES 100: www.floorseal.com.
c. Koster American Corporation; Koster VAP 1 2000: www.kosterusa.com.
d. TEC, an H.B. Fuller Construction Products Brand; TEC LiquiDam EZ with TEC Level Set 200 SLU: www.tecspecialty.com.
e. UZIN, a division of UFLOOR Systems Inc; UZIN PE 460: www.ufloorsystems.com.

## PART 3 - EXECUTION

3.1 CONCRETE SLAB PREPARATION

A. Perform following operations in the order indicated:

1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:

a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
b. Removal of existing floor covering.

2. Preliminary cleaning.
3. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.

4. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
5. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
6. Specified remediation, if required.
7. Patching, smoothing, and leveling, as required.
8. Other preparation specified.
9. Adhesive bond and compatibility test.
10. Protection.

B. Remediations:

1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating over entire suspect floor area.
3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

## 3.2 REMOVAL OF EXISTING FLOOR COVERINGS

A. Comply with local, State, and federal regulations and recommendations of RFCI Recommended Work Practices for Removal of Resilient Floor Coverings, as applicable to floor covering being removed.

B. Dispose of removed materials in accordance with local, State, and federal regulations and as specified.

## 3.3 PRELIMINARY CLEANING

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

## 3.4 MOISTURE VAPOR EMISSION TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F1869 and as follows.

D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.

F. Report: Report the information required by the test method.

## 3.5 INTERNAL RELATIVE HUMIDITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F2170 Procedure A and as follows.

D. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

F. Report: Report the information required by the test method.

## 3.6 ALKALINITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. The following procedure is the equivalent of that described in ASTM F710, repeated here for the Contractor's convenience.

C. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.

D. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (pH) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (pH) reading.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.7 PREPARATION

A. See individual floor covering section(s) for additional requirements.

B. Comply with requirements and recommendations of floor covering manufacturer.

C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.

D. Do not fill expansion joints, isolation joints, or other moving joints.

3.8 ADHESIVE BOND AND COMPATIBILITY TESTING

A. Comply with requirements and recommendations of floor covering manufacturer.

3.9 APPLICATION OF REMEDIAL FLOOR COATING

A. Comply with requirements and recommendations of coating manufacturer.

3.10 PROTECTION

A. Cover prepared floors with building paper or other durable covering.

**END OF SECTION**

**SECTION 09 21 16.23**

**GYPSUM BOARD SHAFT WALL ASSEMBLIES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each component of gypsum board shaft wall assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For shaft wall assemblies, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Fire-Resistance Rating: As indicated on drawings.

B. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.

1. Depth: As indicated.
2. Minimum Base-Metal Thickness: As indicated.

C. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.

1. Minimum Base-Metal Thickness: As indicated Retain "Firestop Tracks" Paragraph below if required.

D. Firestop Tracks: Provide firestop track at head of shaft wall on each floor level.

E. Room-Side Finish: As indicated

F. Shaft-Side Finish: Gypsum shaftliner board, moisture- and mold-resistant Type X as indicated by fire-resistance-rated assembly design designation.

G. Insulation: Sound attenuation blankets.

2.3 PANEL PRODUCTS

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Gypsum Shaft Liner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
b. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
c. Lafarge North America, Inc.; Firecheck Moldcheck Type X Shaftliner.
d. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.

e. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.

2. Thickness: 1 inch
3. Long Edges: Double bevel.
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

C. Gypsum Board: As specified in Section 092900 "Gypsum Board."

D. Cementitious Backer Units: As specified in Section 092900 "Gypsum Board." Section 093000 "Tiling."

## 2.4 NON-LOAD-BEARING STEEL FRAMING

A. Steel Framing Members: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

1. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G60, hot-dip galvanized unless otherwise indicated.

B. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
b. Grace Construction Products; FlameSafe FlowTrak System.
c. Metal-Lite, Inc.; The System.
d. Steel Network Inc. (The); VertiTrack VTD Series.

## 2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.

1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.

2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 conducted by a qualified testing agency.

E. Acoustical Sealant: As specified in Section 092900 "Gypsum Board."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 078100 "Applied Fireproofing."

B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

### 3.3 INSTALLATION

A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.

B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

1. Reinforcing: Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.

D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.

F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

G. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.

H. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.

I. Cant Panels: At projections into shaft exceeding 4 inches, install 1/2- or 5/8-inch-thick gypsum board cants covering tops of projections.

1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft wall framing.
2. Where steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft wall framing.

J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

## 3.4 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION**

**SECTION 09 22 16**

**NON-STRUCTURAL METAL FRAMING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATION SUBMITTALS

A. Evaluation Reports: For firestop tracks, from ICC-ES.

## PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized, unless otherwise indicated.

B. Studs and Runners: ASTM C 645.Use either steel studs and runners or dimpled steel studs and runners.

1. Steel Studs and Runners:

a. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm).
b. Depth: As indicated on Drawings.

2. Dimpled Steel Studs and Runners:

a. Minimum Base-Metal Thickness: 0.025 inch (0.64 mm).
b. Depth: As indicated on Drawings

C. Slip-Type Head Joints: Where indicated, provide the following:

1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (51-mm) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: Subject to compliance with requirements, provide one of the following:

1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
2) MBA Building Supplies
3) Steel Network Inc. (The)
4) Superior Metal Trim; Superior Flex Track System (SFT).
5) Telling Industries

D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fire Trak Corp.

b. Grace Construction Products; FlameSafe FlowTrak System.
c. Metal-Lite, Inc.; The System

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: 0.027 inch (0.68 mm).

F. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm) wide flanges.

1. Depth: 1-1/2 inches (38 mm).
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm) thick, galvanized steel.

G. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm).
2. Depth: 7/8 inch (22.2 mm).

H. Resilient Furring Channels: 1/2-inch- (13-mm) deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

I. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm) wide flanges.

1. Depth: 3/4 inch (19 mm).
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch (0.8 mm).
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm) diameter wire, or double strand of 0.048-inch- (1.21-mm) diameter wire.

J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm), and depth required to fit insulation thickness indicated.

## 2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm) diameter wire, or double strand of 0.048-inch- (1.21-mm) diameter wire.

B. Hanger Attachments to Concrete:

1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
   a. Cast-in-place anchor, designed for attachment to concrete forms.
   b. Postinstalled, chemical anchor.

c. Postinstalled, expansion anchor.

2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to **10** times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Flat Hangers: Steel sheet, 1 by 3/16 inch (25 by 5 mm) by length indicated.

E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm) wide flanges.

1. Depth: 1-1/2 inches (38 mm).

F. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm) wide flanges, 3/4 inch (19 mm) deep.
2. Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm).
b. Depth: As indicated on Drawings

3. Dimpled Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: 0.025 inch (0.64 mm).
b. Depth: As indicated on Drawings

4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.

a. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm).

5. Resilient Furring Channels: 1/2-inch- (13-mm) deep members designed to reduce sound transmission.

a. Configuration: Asymmetrical or hat shaped.

G. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Armstrong World Industries, Inc.; Drywall Grid Systems.
b. Chicago Metallic Corporation; Drywall Grid System.
c. USG Corporation; Drywall Suspension System.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.

1. Space studs as follows:

a. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
b. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
c. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

a. Install two studs at each jamb unless otherwise indicated.
b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.

c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:

   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs **6** inches (150 mm) o.c.

D. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

E. Z-Furring Members:

1. Erect insulation (specified in Section 072100 "Thermal Insulation") vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

## 3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

    a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

**END OF SECTION**

**SECTION 09 29 00**

**GYPSUM BOARD**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board for ceilings and soffits.
3. Abuse and Impact resistant gypsum board for walls
4. Tile backing panels.
5. Texture finishes.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
3. Section 092116 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
4. Section 093000 "Tiling" for cementitious backer units installed as substrates for ceramic tile.

### 1.3 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

### 1.4 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. Lafarge North America Inc.
5. National Gypsum Company.
6. PABCO Gypsum.
7. Temple-Inland.
8. USG Corporation.

B. Gypsum Wallboard: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

C. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.

2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

D. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Thickness: 1/4 inch.
2. Long Edges: Tapered.

E. Gypsum Ceiling Board: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

F. Foil-Backed Gypsum Board: ASTM C 1396/C 1396M.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

G. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M, Level 3.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

H. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

## 2.4 SPECIALTY GYPSUM BOARD

A. Gypsum Board, Type C: ASTM C 1396/C 1396M. Manufactured to have increased fire-resistive capability.

1. Products: Subject to compliance with requirements, provide one of the following:

a. American Gypsum; Firebloc Type C.
b. CertainTeed Corp.; ProRoc Type C.
c. Georgia-Pacific Gypsum LLC; Fireguard C.
d. Lafarge North America Inc.; Firecheck Type C.
e. National Gypsum Company; Gold Bond Fire-Shield C.
f. PABCO Gypsum; Flame Curb Type Super C.
g. Temple-Inland; Type TG-C.
h. USG Corporation; Firecode C Core.

2. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
3. Long Edges: Tapered.

B. Glass-Mat Interior Gypsum Board: ASTM C 1658/C 1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Georgia-Pacific Gypsum LLC; DensArmour Plus.
   b. Architect approved equal

2. Core: 5/8 inch, Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

C. Acoustically Enhanced Gypsum Board: ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. National Gypsum Company; Sound Break.
   b. Quiet Solution, Quiet Rock.
   c. Architect approved equal.

2. Core: 5/8 inch, Type X.
3. Long Edges: Tapered.

D. Skim-Coated Gypsum Board: ASTM C 1396/C 1396M. Manufactured with a factory-applied skim coat.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Lafarge North America Inc.; Rapid Deco L5.
   b. Architect approved equal.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Long Edges: Tapered.

## 2.5 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

A. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. American Gypsum.
   b. CertainTeed Corp.
   c. Georgia-Pacific Gypsum LLC.
   d. Lafarge North America Inc.
   e. National Gypsum Company.
   f. PABCO Gypsum.
   g. Temple-Inland.

h. USG Corporation.

2. Core: 5/8 inch (15.9 mm), Type X.

B. Glass-Mat Gypsum Sheathing Board: ASTM C 1177/C 1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; GlasRoc Sheathing.
b. Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
c. National Gypsum Company; Gold Bond, e(2)XP.
d. USG Corporation; Securock Glass Mat Sheathing.

2. Core: 5/8 inch (15.9 mm), Type X.

C. Cellulose Fiber-Reinforced Gypsum Sheathing Board: ASTM C 1278/C 1278M, gypsum sheathing, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. USG Corporation; Fiberock Aqua-Tough.
b. Architect approved equal.

2. Type and Thickness: Type X, 5/8 inch thick.
3. Size: 48 by 96 inches.

2.6 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; GlasRoc Tile Backer.
b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
c. Architect approved equal.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

B. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:

a. C-Cure
b. CertainTeed Corp.
c. Custom Building Products
d. FinPan, Inc.

e. James Hardie Building Products, Inc.
f. National Gypsum Company
g. USG Corporation

2. Thickness: 1/2 inch.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

C. Water-Resistant Gypsum Backing Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Gypsum.
b. CertainTeed Corp.
c. Georgia-Pacific Gypsum LLC.
d. Lafarge North America Inc.
e. PABCO Gypsum.
f. Temple-Inland.
g. USG Corporation.

2. Core: 5/8 inch, Type X.

2.7 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc
2. Shapes:

a. Cornerbead.
b. Bullnose bead.
c. LC-Bead: J-shaped; exposed long flange receives joint compound.
d. L-Bead: L-shaped; exposed long flange receives joint compound.
e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
f. Expansion (control) joint.
g. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Exterior Trim: ASTM C 1047.

1. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
2. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Fry Reglet Corp.
    b. Gordon, Inc.
    c. Pittcon Industries.

2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.8 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

E. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2. Cementitious Backer Units: As recommended by backer unit manufacturer.
3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

## 2.9 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Laminating adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
b. Grabber Construction Products; Acoustical Sealant GSC.
c. Pecora Corporation
d. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
e. USG Corporation; SHEETROCK Acoustical Sealant.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Acoustical joint sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

G. Vapor Retarder: As specified in Section 072100 "Thermal Insulation."

2.10 TEXTURE FINISHES

A. Primer: As recommended by textured finish manufacturer.

B. Polystyrene Aggregate Ceiling Finish: Water-based, job-mixed, polystyrene aggregate finish with flame-spread and smoke-developed indexes of not more than 25 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Georgia-Pacific Gypsum LLC; ToughRock Ceiling Textures/Polystyrene.
b. National Gypsum Company; ProForm Perfect Spray.
c. USG Corporation; SHEETROCK Ceiling Spray Texture, QT.

2. Texture: Fine.

C. Aggregate Finish: Water-based, job-mixed, aggregated, drying-type texture finish for spray application.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; ProRoc Wall and Ceiling Spray Texture.
b. Georgia-Pacific Gypsum LLC; ToughRock Ceiling Textures/Vermiculite.
c. USG Corporation; SHEETROCK Wall and Ceiling Spray Texture (Aggregated).

2. Texture: Light spatter

D. Non-Aggregate Finish: Pre-mixed, vinyl texture finish for spray application.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; ProRoc Easi-Tex Spray Texture.
b. National Gypsum Company; Perfect Spray EM Texture.
c. USG Corporation; BEADEX FasTex Wall and Ceiling Spray Texture.

2. Texture: Orange Peel

E. Acoustical Finish: Water-based, chemical-setting or drying-type, job-mixed texture finish for spray application.

1. Products: Subject to compliance with requirements, provide one of the following:

a. International Cellulose Corp.; SonaSpray "fc."
b. USG Corporation; USG Acoustical Plaster Finish.
c. Architect approved equal.

2. Application Thickness: 1/2 inch
3. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 25 or less.
    b. Smoke-Developed Index: 50 or less.

4. NRC: 0.55 according to ASTM C 423.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

## 3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Wallboard Type: Vertical surfaces unless otherwise indicated.
2. Type X: Where required for fire-resistance-rated assembly.
3. Flexible Type: Apply in double layer at curved assemblies.
4. Ceiling Type: Ceiling surfaces.
5. Foil-Backed Type: As indicated on Drawings.
6. Abuse-Resistant Type: As indicated on Drawings.
7. Moisture- and Mold-Resistant Type: As indicated on Drawings.
8. Type C: Where required for specific fire-resistance-rated assembly indicated.
9. Glass-Mat Interior Type: As indicated on Drawings.
10. Acoustically Enhanced Type: As indicated on Drawings.
11. Skim-Coated Type: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

E. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

## 3.4 APPLYING EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

## 3.5 APPLYING TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at showers, tubs, and where indicated. Install with 1/4-inch gap where panels abut other construction or penetrations.

B. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated.

C. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.

D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

## 3.6 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. Bullnose Bead: Use at outside corners.
3. LC-Bead: Use at exposed panel edges
4. L-Bead: Use where indicated
5. U-Bead: Use at exposed panel edges.
6. Curved-Edge Cornerbead: Use at curved openings.

D. Exterior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.

E. Aluminum Trim: Install in locations indicated on Drawings.

## 3.7 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840. Primer and its application to surfaces are specified in other Section 099100 "Finish Painting.":

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile or acoustical tile.
3. Level 3:
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
5. Level 5: At surfaces receiving gloss and semigloss enamels and circulation surfaces. It is considered a high-quality gypsum board finish.

E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

## 3.8 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture matching approved mockup and free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written recommendations.

## 3.9 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION**

**SECTION 09 30 13**

**CERAMIC TILING**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceramic mosaic tile.
2. Porcelain tile.
3. Waterproof membrane[ **for thinset applications**].
4. Crack isolation membrane.
5. Metal edge strips.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples:

1. Each type and composition of tile and for each color and finish required.
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required.
3. Stone thresholds.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
3. Installer employs Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of[ **each type of** floor tile installation.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

### 2.2 TILE PRODUCTS

A. Ceramic Tile Type **CFT**: Porcelain tile.

1. Manufacturer: Daltile Fabric Art Colorbody Porcelain Tile, “Modern Linear” (Basis of Design) or approved equal.
2. Certification: Tile certified by the Porcelain Tile Certification Agency.
3. Face Size: **12 by 24 inches, nominal**.
4. Thickness: **5/16 inch**.
5. Face: **As indicated**.
6. Dynamic Coefficient of Friction: Not less than 0.42.
7. Tile Color, Glaze, and Pattern:
   a. CFT-1: Modern Linear “White” ML60.
   b. CFT-2: Modern Linear “Taupe” ML62
8. Grout Color: **As selected by Architect from manufacturer's full range**.

### 2.3 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.

## 2.4 WATERPROOF MEMBRANE

A. General: Manufacturer's standard product**, selected from the following,** that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane.
b. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh.
c. Approved equal.

## 2.5 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product**, selected from the following,** that complies with ANSI A118.12 for **high performance** and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Laticrete International, Inc.; Laticrete 9235 Waterproof Membrane.
b. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh.
c. Approved equal.

C. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

1. Products: Subject to compliance with requirements, provide one of the following:

a. C-Cure; Pro-Red Waterproofing Membrane 963.
b. Approved equal.

## 2.6 SETTING MATERIALS

A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.

1. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
2. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.

3. Expanded Metal Lath: Diamond-mesh lath complying with ASTM C 847.

    a. Base Metal and Finish for Interior Applications: Uncoated or zinc-coated (galvanized) steel sheet, with uncoated steel sheet painted after fabrication into lath.
    b. Configuration over Solid Surfaces: Self-furring.
    c. Weight: 3.4 lb/sq. yd.

4. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed Portland cement and aggregate mortar bed.

B. Latex-Portland Cement Mortar (Thin Set): ANSI A 118.4.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. C-Cure.
    b. Laticrete International, Inc.
    c. MAPEI Corporation.
    d. TEC; a subsidiary of H. B. Fuller Company.

2. Provide pre-packaged, dry-mortar mix containing dry, re-dispersible vinyl acetate or acrylic additive to which only water shall be added at Project Site.
3. Provide pre-packaged, dry mortar mix combined with acrylic resin liquid latex additive at Project Site.

## 2.7 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. Polymer-Modified Tile Grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. C-Cure.
    b. Laticrete International, Inc.
    c. MAPEI Corporation.
    d. TEC; a subsidiary of H. B. Fuller Company.

2. Type: Ethylene vinyl acetate or Acrylic additive, in dry, re-dispersible form, pre-packaged with other dry ingredients.

## 2.8 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.

1. Product: Schluter Systems edge strips for exposed vertical and horizontal tile edges, and as indicated on the Drawings.

C. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surface of tile against adherence of mortar and grout; compatible with tile, mortar and grout products; and easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.l5 percent oil with a melting point of 12 to 140 degrees F per ASTM D 87.
2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by the tile and grout manufacturers.

E. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Bostik, Inc.; CeramaSeal Grout & Tile Sealer.
b. C-Cure; Penetrating Sealer 978.
c. Custom Building Productgs; Grout and Tile Sealer.
d. MAPEI Corporation; KER 004, Keraseal Penetrating Sealer for Unglazed Grout and Tile.

## 2.9 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with **adhesives or thinset mortar** comply with surface finish requirements in ANSI A108.01 for installations indicated.
3. Verify that grounds, anchors, recessed frames, electrical and mechanical units of work and similar items located on or behind tile have been completed.
4. Verify that joints and cracks in tile substrates are coordinate dwith tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with **adhesives or thinset mortar** with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, pre-coat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

## 3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:

    a. Tile floors in wet areas.
    b. Tile floors in laundries.
    c. Tile floors consisting of tiles 8 by 8 inches or larger.
    d. Tile floors consisting of rib-backed tiles.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

**1.** Porcelain Tile: **3/16 inch.**

H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

I. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile and no threshold is indicated.

J. Floor Sealer: Apply floor sealer to **cementitious** grout joints **in tile floors** according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

**K.** Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. **Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.**

L. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

M. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

3.4 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

1. Ceramic Tile Installation **CTF-1**: TCNA F111 and **ANSI A108.1C**; cement mortar bed with cleavage membrane.

   a. Ceramic Tile Type: Daltile Fabric Art Colorbody Porcelain Tile, Modern Linear **"White" ML60**.
   b. Thin-Set Mortar for Cured-Bed Method: Latex- Portland cement mortar.
   c. Grout: Polymer-modified sanded grout.

2. Ceramic Tile Installation **CTF-2**: TCNA F111 and **ANSI A108.1C**; cement mortar bed with cleavage membrane.

   a. Ceramic Tile Type: Daltile Fabric Art Colorbody Porcelain Tile, Modern Linear **"Taupe" ML62**.
   b. Thin-Set Mortar for Cured-Bed Method: Latex- Portland cement mortar.
   c. Grout: Polymer-modified sanded grout.

**END OF SECTION**

**SECTION 09 50 00**

**ACOUSTICAL CEILINGS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Acoustical ceiling panels
2. Exposed grid suspension system
3. Wire hangers, fasteners, main runners, cross tees, and wall angle moldings
4. Perimeter Trim

B. Related Sections

1. Section 09 29 00 - Gypsum Board
2. Division 23 – HVAC
3. Division 26 – Electrical

C. Alternates

1. Prior Approval: Unless otherwise provided for in the Contract documents, proposed product substitutions may be submitted no later than TEN (10) working days prior to the date established for receipt of bids. Acceptability of a proposed substitution is contingent upon the Architect's review of the proposal for acceptability and approved products will be set forth by the Addenda. If included in a Bid are substitute products that have not been approved by Addenda, the specified products shall be provided without additional compensation.
2. Submittals that do not provide adequate data for the product evaluation will not be considered. The proposed substitution must meet all requirements of this section, including but not necessarily limited to, the following: Single source materials suppliers (if specified in Section 1.5); Underwriters' Laboratories Classified Acoustical performance; Panel design, size, composition, color, and finish; Suspension system component profiles and sizes; Compliance with the referenced standards.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
2. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
3. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
4. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
5. ASTM C 635 Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
6. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
7. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
8. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
9. ASTM E 119 Standard Test Methods for Fire Tests of Building Construction and Material

    a. Armstrong Fire Guard Products

10. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
11. ASTM E 1111 Standard Test Method for Measuring the Interzone Attenuation of Ceilings Systems
12. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
13. ASTM E 1264 Classification for Acoustical Ceiling Products

B. 2019 Chicago Building Code

C. ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality

D. NFPA 70 National Electrical Code

E. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures

F. International Code Council-Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components

G. International Code Council-Evaluation Services Report - Seismic Engineer Report

1. ESR 1308 - Armstrong Suspension Systems

H. International Association of Plumbing and Mechanical Officials - Seismic Engineer Report

1. 0244 - Armstrong Single Span Suspension System

1.4 SYSTEM DESCRIPTION;

A. Continuous/Wall-to-Wall

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.

B. Samples: Minimum 6 inch x 6 inch samples of specified acoustical panel; 8 inch long samples of exposed wall molding and suspension system, including main runner and 4 foot cross tees.

C. Shop Drawings: Layout and details of acoustical ceilings show locations of items that are to be coordinated with, or supported by the ceilings.

D. Acoustical Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC, CAC, and AC.

1. If the material supplied by the acoustical subcontractor does not have an Underwriter's Laboratory classification of acoustical performance on every carton, subcontractor shall be required to send material from every production run appearing on the job to an independent or NVLAP approved laboratory for testing, at the architect's or owner's discretion. All products not conforming to manufacturer's current published values must be removed, disposed of and replaced with complying product at the expense of the Contractor performing the work.

1.6 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.

1. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.
2. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 Classification.
3. Fire Resistance: As follows tested per ASTM E119 and listed in the appropriate floor or roof design in the Underwriters Laboratories Fire Resistance Directory.

B. Acoustical Panels: As with other architectural features located at the ceiling, may obstruct or skew the planned fire sprinkler water distribution pattern through possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and suppression systems are present.

C. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.8 PROJECT CONDITIONS

A. Standard Ceilings: Do not install interior ceilings until space is enclosed and weatherproof; wet work in place is completed and nominally dry; work above ceilings is complete; and ambient conditions of temperature and humidity are continuously maintained at values near those intended for final occupancy. Building areas to receive ceilings shall be free of construction dust and debris.

1.9 ALTERNATE CONSTRUCTION WASTE DISPOSAL

A. Ceiling material being reclaimed must be kept dry and free from debris.

B. Contact the Armstrong Recycle Center a consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant with provide assistance to facilitate the recycling of the ceiling.

1.10 WARRANTY

A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:

1. Acoustical Panels: Sagging and warping
2. Grid System: Rusting and manufacturer's defects

B. Warranty Period:

1. Acoustical panels: Ten (10) years from date of substantial completion
2. Suspension: Ten (10) years from date of substantial completion
3. Ceiling System: Thirty (30) years from date of substantial completion

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.11 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.

1. Acoustical Ceiling Units: Furnish quality of full-size units equal to 5.0 percent of amount installed.
2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Ceiling Panels:

1. Armstrong World Industries, Inc.

B. Suspension Systems:

1. Armstrong World Industries, Inc.

C. Perimeter Systems

1. Armstrong World Industries, Inc.

2.2 ACOUSTICAL CEILING UNITS

A. Acoustical Panels Type ACT-1
1. Surface Texture: Fine
2. Composition: Fiberglass
3. Color: White
4. Size: 24 in x 24 in
5. Edge Profile: Square Tegular 9/16 in for interface with SILHOUETTE XL 9/16" Bolt Slot - 1/8" Reveal grid.
6. Noise Reduction Coefficient( NRC): ASTM C 423; Classified with UL label on product carton 0.90
7. Ceiling Attenuation Class (CAC) : ASTM C 1414; Classified with UL label on product carton 26
8. Sabin:N/A
9. Articulation Class (AC): ASTM E 1111; Classified with UL label on product carton 200
10. Flame Spread: ASTM E 1264; Class A (UL)

11. Light Reflectance (LR) White Panel: ASTM E 1477; 0.88
12. Dimensional Stability: HumiGuard Plus
13. Recycle Content: Post-Consumer - 12% Pre-Consumer - 59%
14. Acceptable Product: OPTIMA Tegular, 3355 as manufactured by Armstrong World Industries

2.3 METAL SUSPENSION SYSTEMS

A. Components:
   1. Main beams and cross tees, base metal and end detail, fabricated from commercial quality hot dipped galvanized steel complying with ASTM A 653. Main beams and cross tees are double-web steel construction with type exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching.
      a. Structural Classification: ASTM C 635 Heavy Duty duty
      b. Color: White and match the actual color of the selected ceiling tile, unless noted otherwise.
      c. Sustainability: Environmetal Product Declaration (EPD), Health Product Declaration (HPD)
      d. Acceptable Product: SILHOUETTE XL 9/16" Bolt Slot - 1/8" Reveal as manufactured by Armstrong World Industries

B. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

C. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft annealed, with a yield stress load of at least time three design load, but not less than 12 gauge.

D. Edge Moldings and Trim:

E. Accessories:

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.

B. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.

1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

## 3.3 INSTALLATION

A. Follow manufacturer installation instructions.

B. Install suspension system and panels in accordance with the manufacturer's instructions, and in compliance with ASTM C 636 and with the authorities having jurisdiction.

C. Suspend main beam from overhead construction with hanger wires spaced 4-0 on center along the length of the main runner. Install hanger wires plumb and straight.

D. Install wall moldings at intersection of suspended ceiling and vertical surfaces. Miter corners where wall moldings intersect or install corner caps.

E. For reveal edge panels: Cut and reveal or rabbet edges of ceiling panels at border areas and vertical surfaces.

F. Install acoustical panels in coordination with suspended system, with edges resting on flanges of main runner and cross tees. Cut and fit panels neatly against abutting surfaces. Support edges by wall moldings.

## 3.4 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any ceiling products that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.

C. Before disposing of ceilings, contact the Armstrong Recycling Center at 877-276-7876, select option #1 then #8 to review with a consultant the condition and location of building where the ceilings will be removed. The consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant with provide assistance to facilitate the recycle of the ceiling.

**END OF SECTION**

**SECTION 09 52 00**

**WOOD WALL PANEL TREATMENT (ARMSTRONG WOODWORKS GRILLE)**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wood grille wall panels
2. Mounting hardware and materials

B. Related Sections

1. The following work is not included in this Section and is to be performed under the designated Sections:

a. Section 06 10 00, Rough Carpentry: wood blocking and nailers to receive fastenings.
b. Section 06 20 23, Interior Finish Carpentry: installation of wood grille finish panels.
c. Section 09 22 16, Metal Stud Framing: blocking to receive fastenings.
d. Section 09 29 00, Gypsum Board: gypsum board substrates to which acoustical wall panels are applied.
e. Section 09900, Painting: finish of wall surface behind and between paneling.

C. Alternates

1. Prior Approval: Unless otherwise provided for in the Contract Documents, proposed product substitutions may be submitted no later than TEN (10) working days prior to the date established for receipt of bids. Approval of a proposed substitution is contingent upon the Architect's review of the proposal for acceptability, and approved products will be set forth by Addenda.

a. If substitute products that have not been approved by Addenda are included in a Bid, the specified products shall be provided without additional compensation.

2. Submittals that do not provide adequate data for the product evaluation will not be considered. The proposed substitution must meet all requirements of this Section, including but not necessarily limited to the following: Single source materials supplier (if specified in Section 1.05); Panel design, size, composition, color and finish; Suspension system component profiles and sizes; Compliance with the referenced standards

1.3 REFERENCES

A. ASTM C 423 “Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method”

B. ASTM E 84 “Standard Test Method for Surface Burning Characteristics of Building Materials”

1.4 SUBMITTALS

A. Product Data: Manufacturer’s technical literature and installation instructions.

B. Samples: Minimum 8" x 11" samples of specified acoustical panel; representative samples of installation devices and accessories.

C. Certifications: Manufacturer’s certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards

1.5 QUALITY ASSURANCE

A. Single Source Responsibility: To ensure proper interface and color match, all acoustical panel units and grid components shall be produced or supplied by a single manufacturer. Materials supplied by more than one manufacturer are not permissible.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer’s unopened packages; suitably store to protect against exposure to moisture, sunlight, surface contamination, and other unacceptable conditions.

B. Handle components to prevent panel edge damage or any other damage to components.

1.7 PROJECT CONDITIONS

A. Environmental Requirements at installation

1. The building shall be enclosed, the air conditioning system shall be operating with proper filters in place and the proper temperature and humidity conditions shall be stabilized before, during and following installation until Substantial Completion. Building areas to receive ceilings shall be free of construction dust and debris.
2. Coordination: Coordinate acoustical ceilings work with installers of related work including, but not necessarily limited to, building insulation, gypsum drywall, mechanical systems and electrical systems.

B. Dimensional Stability:

1. WoodWorks Grille Wall Panels: Installation shall be carried out in temperature conditions between 50°F (10°C) and 86°F (30°C) and in spaces where the building is enclosed and HVAC systems are functioning and will be in continuous operation.

1.8 WARRANTY (LIMITED)

A. Wall Panels: Submit a written warranty executed by the manufacturer, agreeing to repair or replacement of acoustical panels that fail within the warranty period. Failures include, but are not necessarily limited to:

1. WoodWorks Grille Panels: Sagging, warping and manufacturer's defects.

B. Warranty period for WoodWorks panels is one (1) year from date of Substantial Completion.

C. The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents. Set out in full.

1.9 MAINTENANCE

A. Extra Materials: Deliver and furnish extra material to owner, as described below, to match products installed. Package with protective covering for storage and identify with appropriate labels.

1. WoodWorks Grille Panels: Furnish quantity of full size units equal to 5% of the amount installed.

**PART 2 - PRODUCTS**

2.1 MANUFACTURER

A. Basis of Design: The materials are either manufactured by or for Armstrong World Industries, Inc. (the "Scheduled Manufacturer")

B. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.

2.2 MATERIALS

A. Wood Slat Wall: Type WS-1

B. Type: Armstrong WoodWorks Grille #7263 BOGMP Slat Wall Panels – Solid wood backer with 6 slats per panel.

C. Performance Characteristics:

1. Flame Spread: ≤ 200, per ASTM E 84
2. Smoke Developed: ≤ 450 per ASTM E 84

D. Climatization: all WorkWorks components shall be acclimatized prior to installation:

1. Relative Humidity: between 25% and 55%
2. Temperatures: between 50 degrees and 86 degrees F.

E. Physical Data:

1. Material - Slats, Backers and Dowels: Solid Poplar (yellow or hybrid)
2. Surface Finish: Tinted semigloss coating.
3. Size:

a. Panel Dimensions: 12” x 96” x 1-7/8” nominal, with backer only.
b. Slat Width: 5/8”
c. Slat Depth: 1-3/8”
d. Slats per Panel: 6

4. Finish: Grille Maple-GMP

F. Accessories:

1. Manufacturer's standard or recommended accessories for securely mounting panels of type and size indicated to substrates provided.
2. Junction: 5672 GMP
3. Edge Detail

2.3 LIMITATIONS

A. For WoodWorks Grille Wood Panel surface burning verification, Armstrong used the Hardwood Plywood & Veneer Association Laboratory and Testing Service, Test Method ASTM E 84, (i.e., UL723, NFPA 255). This product has a Class A rating based on this test.

B. Based on (NFPA 259) test data, the WoodWorks Grille Wood Panels are not acceptable for use in air handling plenums under NFPA 90A (Standard for the Installation of Air-Conditioning and Ventilating Systems) and therefore should not be installed in areas where that standard applies. These materials do not meet the limited combustible requirements for ceilings used in the construction of air-handling plenums.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Examine construction and conditions under which system will be installed. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Installation to be performed by Finish Carpenter familiar with product and installation methods. Field cutting will be performed using factory approved trims, adhesives and methods.

B. Install acoustical wall panels in locations indicated with vertical surfaces and edges plumb, top edges level, and in alignment with other panels, scribed to fit adjoining work accurately at borders and at penetrations.

C. Comply with manufacturer's printed instructions for installation of panels using type of mounting accessories indicated or, if none indicated, as recommended by manufacturer.

D. Concealed aluminum panel clips to be factory-attached to the back of the panels, or continuous Z track fastened to existing ceiling system. Clip spacing to be max. horizontal centers of 24". Adhesively mounted clips are not acceptable.

E. Remove and replace panels which are damaged and are unacceptable to Architect.

F. Panels shall be spot cleaned to remove any finger marks or soil.

3.3 ADJUSTING AND CLEANING

A. Upon completion of work, remove all rubbish and excess material resulting from the work of this Section from building and leave areas in clean satisfactory condition.

**END OF SECTION**

**SECTION 09 54 23**

**LINEAR METAL CEILINGS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Acoustical metal ceiling panels
2. Exposed grid suspension system
3. Wire hangers, fasteners, main runners, cross tees, and wall angle moldings
4. Perimeter Trim

B. Related Sections

1. Section 09 29 00 - Gypsum Board
2. Section 09 50 00 - Acoustical Ceilings
3. Division 23 – HVAC
4. Division 26 – Electrical

C. Alternates

1. Prior Approval: Unless otherwise provided for in the Contract documents, proposed product substitutions may be submitted no later than TEN (10) working days prior to the date established for receipt of bids. Acceptability of a proposed substitution is contingent upon the Architect's review of the proposal for acceptability and approved products will be set forth by the Addenda. If included in a Bid are substitute products that have not been approved by Addenda, the specified products shall be provided without additional compensation.
2. Submittals that do not provide adequate data for the product evaluation will not be considered. The proposed substitution must meet all requirements of this section, including but not necessarily limited to, the following: Single source materials suppliers (if specified in Section 1.5); Underwriters' Laboratories Classified Acoustical performance; Panel design, size, composition, color, and finish; Suspension system component profiles and sizes; Compliance with the referenced standards.

### 1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
2. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
3. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
4. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
5. ASTM C 635 Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
6. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
7. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
8. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
9. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
10. ASTM E 1111 Standard Test Method for Measuring the Interzone Attenuation of Ceilings Systems
11. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
12. ASTM E 1264 Classification for Acoustical Ceiling Products

B. Chicago Building Code

C. ASHRAE Standard 62 1 2004 Ventilation for Acceptable Indoor Air Quality

D. NFPA 70 National Electrical Code

E. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures

## 1.4 SYSTEM DESCRIPTION

A. Continuous/Wall-to-Wall

## 1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.

B. Samples: Minimum 6 inch x 6 inch samples of specified acoustical panel; 8 inch long samples of exposed wall molding and suspension system, including main runner and 4 foot cross tees.

C. Shop Drawings: Layout and details of acoustical ceilings show locations of items that are to be coordinated with, or supported by the ceilings.

D. Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For

acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC, CAC, and AC.

E. If the material supplied by the acoustical subcontractor does not have an Underwriter's Laboratory classification of acoustical performance on every carton, subcontractor shall be required to send material from every production run appearing on the job to an independent or NVLAP approved laboratory for testing, at the architect's or owner's discretion. All products not conforming to manufacturer's current published values must be removed, disposed of and replaced with complying product at the expense of the Contractor performing the work.

1.6 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.

B. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.

1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 Classification.

C. Acoustic Panels: As with other architectural features located at the ceiling, may obstruct or skew the planned fire sprinkler water distribution pattern through possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and suppression systems are present.

D. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.8 PROJECT CONDITIONS

A. Space Enclosure:

1. Standard Ceilings: Do not install interior ceilings until space is enclosed and weatherproof; wet work in place is completed and nominally dry; work above ceilings is

complete; and ambient conditions of temperature and humidity are continuously maintained at values near those intended for final occupancy. Building areas to receive ceilings shall be free of construction dust and debris.

1.9 WARRANTY

A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:

1. Acoustical Panels: Sagging and warping
2. Grid System: Rusting and manufacturer's defects

B. Warranty Period:

1. Acoustical Metal panels: One (1) year from date of substantial completion
2. Grid: Ten (10) years from date of substantial completion

1.10 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.

1. Acoustical Metal Ceiling Units: Furnish quality of full-size units equal to 5.0 percent of amount installed.
2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Metal Ceiling Panels:

1. Armstrong World Industries, Inc.

B. Suspension Systems:

1. Armstrong World Industries, Inc.

C. Aluminum Custom Trims:

1. Armstrong World Industries, Inc.

2.2 ACOUSTICAL CEILING UNITS

A. Acoustical Panels Type MT-1

1. Surface Texture: Smooth
2. Composition: Metal
3. Color: SG - Silver Grey Exterior
4. Sizes:

    a. 5490 - 4 in x 96 in x 5/8”
    b. 5570 - 12 in x 96 in x 5/8”
    c. See RCP for locations

5. Edge Profile: Square with extended flange
6. Perforation Option: Unperforated
7. Flame Spread: ASTM E 1264; Class A (FM).
8. Dimensional Stability: Standard
9. Recycle Content: Post-Consumer - 0% Pre-Consumer - 25%
10. Acceptable Product: METALWORKS Linear - Classics, 5490 + 5570. No added formaldehyde as manufactured by Armstrong World Industries.

B. Accessories:

1. 5581 - 4" Panel End Cap
2. 5583 - 12" Panel End Cap
3. 5574 – Carrier Molding
4. 7177 – Main Beam Carrier
5. TechZone Yoke TZYK – for linear light fixture integration

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.

B. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.

1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.3 INSTALLATION

A. Follow manufacturer installation instructions

B. Install suspension system and panels in accordance with the manufacturer's instructions, and in compliance with ASTM C 636 and with the authorities having jurisdiction.

C. Install wall moldings at intersection of suspended ceiling and vertical surfaces. Miter corners where wall moldings intersect or install corner caps.

D. For reveal edge panels: Cut and reveal or rabbet edges of ceiling panels at border areas and vertical surfaces.

E. Install acoustical panels in coordination with suspended system, with edges resting on flanges of main runner and cross tees. Cut and fit panels neatly against abutting surfaces. Support edges by wall moldings.

3.4 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of ceilings panels, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

**END OF SECTION**

**SECTION 11 81 29**

**FACILITY FALL PROTECTION**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes fall protection equipment including:

1. Anchorages - Stanchion.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous metal fabrications.
2. Section 055200 "Metal Railings" for utility and decorative railings.
3. Section 076200 "Sheet Metal Flashing and Trim" for flashing and trim components.

1.3 PREINSTALLATION MEETINGS

A. Pre-demolition Conference: Conduct conference at project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's data and product information indicating descriptions, material, dimensions, capacities, and test certifications for fall-protection equipment

B. Shop Drawings:

1. Include plans, elevations, sections, mounting, and attachment details.
2. Include details of equipment assemblies.
3. Include layout drawings for each system in relation to the supporting structure. Indicate locations of components.

C. Samples: For each type of fall-protection equipment specified.

D. Product Schedule: For fall-protection equipment. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For fall-protection equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1. Provide certified proof of Installer's approval by manufacturer.

B. Welding certificates.

C. Product Certificates: For each type of fall-protection equipment indicating manufacturer's batch number on each individual component used in systems specified.

D. Product Test Reports: For each stanchion anchorage and wall anchorage, for tests performed by Rooftop Anchor.

E. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fall-protection equipment to include the following:

1. Parts lists and maintenance requirements.
2. Proper use of equipment for safe operation.
3. Manufacturer's catalog data indicating sizes, descriptions, capacities, and test certifications.

B. Record Documentation: Include Record Drawings in the operation and maintenance manual.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications”

1. Must have 10 years of experience in the manufacturing of the products specified.
2. Must utilize in-house engineers capable of certifying the anchor installation.

B. Installer Qualifications: An entity that employs installers and supervisors who are authorized, trained, and certified by manufacturer.

C. Engineer for Delegated-Design Qualifications: Structural engineer licensed in the jurisdiction and experienced in engineering fall-protection systems.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original unopened packaging.

B. Store materials in original protective packaging.

C. Protect from soiling, moisture, and physical damage.

1.9 FIELD CONDITIONS

A. Coordinate layout and installation of framing and reinforcements for fall-protection equipment.

B. Maintain environmental conditions within limits recommended by manufacturer. Do not install products under environmental conditions outside manufacturer's recommended limits

1.10 WARRANTY

A. Manufacturer’s Warranty: Manufacturer agrees to repair or replace components of fall protection equipment that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: 10 year(s) from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of fall protection equipment from signle source from single manufacturer.

2.2 DESCRIPTION

A. Regulatory Requirements: Products to meet or exceed OSHA, ASME A 120.1, ANSI I-14.1-2001, and ANSI Z-359, as tested and certified by professional engineer.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fall-protection systems.

B. Capacities and Characteristics:

1. Capable of sustaining a maximum fall-arresting force of 1,800 lbf (8.0 kN) when wearing a body harness with a factor of two without any permanent deformation and to 5,000 lbf (22.24 kN) against fracture or detachment.

2.4 ANCHORAGE DEVICES - RE18X104

A. Stanchion Anchorages:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Rooftop Anchor, Inc.: Roof stanchion anchorage.
2. Substitutions not permitted.
3. Attachment Method: Epoxy
4. Roof Anchorage Bolt Quantity: Four.
5. Rooftop Anchorage Height: 18 inches.
6. Working Load: 1,250 lbs. (5.56 kN).
7. Ultimate Load: 5,000 lbs. (22.24 kN)

B. Wall Anchors: WE045006

1. Basis-of-Design Product: Subject to compliance with requirements, provide Rooftop Anchor, Inc.: Wall anchorage.
2. Substitutions not permitted.
3. Attachment Method: Epoxy.
4. Wall-Anchorage Bolt Quantity: Four.
5. Working Load: 1,250 lbs. (5.56 kN).
6. Ultimate Load: 5,000 lbs. (22.24 kN)

2.5 FABRICATION

A. Finish - Thermal Diffused Galvanized finish.

B. Finish Thickness

1. Minimum 5 mils.
2. Maximum 11 mils.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate location of fall-protection equipment, indicated to be attached to structural substrate or surface of roofing system, and furnish anchoring devices with templates and diagrams.

## 3.3 INSTALLATION

A. Install according to approved Shop Drawings and manufacturer's instructions. Coordinate with work of other trades.

B. Install anchorage and fasteners in accordance with manufacturer's recommendations to obtain the allowable working loads published in the product literature and in accordance with this specification.

C. Exposed work shall be true to line and level with accurate angles, surfaces, and with straight square edges. Coordinate anchorage system with supporting structure.

D. Do not load or stress system until materials and fasteners are properly installed and ready for service.

## 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-certified installer to inspect components, assemblies, and equipment installations, including connections.

B. Ensure that system components operate as specified.

## 3.5 ADJUSTING

A. Adjust fall-protection components to function smoothly and safely.

## 3.6 CLEANING

A. Clean components of any harmful coatings or compounds. Remove loose materials, crating, and packing materials from Project site.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to demonstrate operation of system to Owner's maintenance personnel.

1. Describe function, operation, and maintenance of each component.

## 3.8 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel on operation and maintenance of system.

1. Provide minimum of 30 minutes- or more as required- of training.
2. Provide training at fall-protection installation site.
3. Training to take place at the completion of the installation.

3.9 MAINTENANCE

A. OSHA 1910.27 and ANSI/IWCA I 14.1 require that anchors first be certified and subsequently inspected on an annual basis under the supervision of a Qualified Person. Coordinate with the manufacturer and local inspectors as required to maintain compliance. OSHA also requires Retest & Certify every 5-years for chemical mounted fasteners, under the supervision of a Qualified Person

**END OF SECTION**

**SECTION 21 13 13**

**WET-PIPE SPRINKLER SYSTEMS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Pipes and fittings.

B. Related Requirements:

1. Section 22 11 19 “Domestic Water Piping Specialties”, for backflow preventer.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: This work may be submitted on plumbing drawings.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

### 1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.6 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by the CHA or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify the CHA no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without the CHA's written permission.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

B. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

C. Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.

D. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Malleable- or Ductile-Iron Unions: UL 860.

F. Cast-Iron Flanges: ASME 16.1, Class 125.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

I. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International
b. National Fittings, Inc.
c. Smith-Cooper International
d. Tyco by Johnson Controls Company
e. Victaulic Company

2. Pressure Rating: 175-psig minimum.
3. Galvanized and Painted Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

**PART 3 - EXECUTION**

3.1 WATER-SUPPLY CONNECTIONS

A. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 22 11 19 “Domestic Water Piping Specialties”.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install sprinkler piping with drains for complete system drainage.

G. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

H. Fill sprinkler system piping with water.

I. Install escutcheons for piping penetrations of walls, ceilings, and floors.

## 3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

E. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

## 3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.

## 3.5 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

## 3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Train the CHA's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.8 PIPING SCHEDULE

A. Standard-Pressure, wet-pipe sprinkler system shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.

**END OF SECTION**

**SECTION 22 05 23**

**GENERAL-DUTY VALVES FOR PLUMBING PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Bronze Ball Valves
2. Bronze Lift Check Valves
3. Bronze Swing Check Valves
4. Bronze Gate Valves

B. Related Sections:

1. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

### 1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

### 1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: Any product designed for dispensing potable water shall meet both NSF 61 and NSF 372 test standards via third-party testing and certification.

D. Regulatory Requirements: Comply with requirements in Public Law 111-380 “Reduction of Lead in Drinking Water Act,” for valve materials that will be in contact with potable water.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

**PART 2 - PRODUCTS**

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types. (sump pump discharge)
2. Handlever: For quarter-turn valves NPS 3 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With non-rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
1. Solder Joint: With sockets according to ASME B16.18.
2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-110
   b. SWP Rating: 150 psig
   c. CWP Rating: 600 psig
   d. Body Design: Two Piece
   e. Body Material: Bronze
   f. Ends: Threaded
   g. Seats: PTFE or TFE
   h. Stem: Stainless Steel
   i. Ball: Stainless Steel, Vented
   j. Port: Full

## 2.3 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Crane Co.; Crane Valve Group; Crane Valves
   b. Crane Co.; Crane Valve Group; Jenkins Valve.
   c. Crane Co.; Crane Valve Group; Stockham Division

2. Description:

   a. Standard: MSS SP-80, Type 1

b. CWP Rating: 200 psig
c. Body Design: Vertical Flow
d. Body Material: ASTM B 61 or ASTM B 62, bronze
e. Ends: Threaded
f. Disc: Bronze

## 2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves
b. Crane Co.; Crane Valve Group; Jenkins Valves
c. Crane Co.; Crane Valve Group; Stockham Division
d. Kitz Corporation
e. Milwaukee Valve Company
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig
c. Body Design: Horizontal Flow
d. Body Material: ASTM B 62, Bronze
e. Ends: Threaded
f. Disc: PTFE or TFE

## 2.5 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves
b. Crane Co.; Crane Valve Group; Jenkins Valves
c. Crane Co.; Crane Valve Group; Stockham Division
d. Kitz Corporation
e. Milwaukee Valve Company
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:

a. Standard: MSS SP-80, Type 1
b. CWP Rating: 200 psig
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or Solder Joint

e. Stem: Bronze
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos Free
h. Handwheel: Malleable iron, bronze, or aluminum.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

## 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves.
2. Throttling Service: Ball valves.
3. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

## 3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 125, nonmetallic disc.

## 3.6 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves: Class 125, bronze disc.
3. Bronze Gate Valves: Class 125, NRS.

**END OF SECTION**

**SECTION 22 05 29**

**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Metal Pipe Hangers and Supports
2. Trapeze Pipe Hangers
3. Metal Framing Systems
4. Thermal-hanger Shield Inserts
5. Fastener Systems
6. Pipe Positioning Systems
7. Equipment Supports

### 1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

### 1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

### 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates. (for project close-out only)

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

**PART 2 - PRODUCTS**

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Hot-dip galvanized.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit
b. Cooper B-Line, Inc.; a division of Cooper Industries
c. Flex-Strut Inc.

d. Thomas & Betts Corporation, A Member of the ABB Group
e. Unistrut; an Atkore International Company
f. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with in-turned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
7. Metallic Coating: Hot-dipped galvanized.

## 2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services
3. ERICO International Corporation
4. National Pipe Hanger Corporation
5. PHS Industries, Inc.
6. Pipe Shields Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

**PART 3 - EXECUTION**

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

## 3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

## 3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## 3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel metal trapeze pipe hangers and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

**END OF SECTION**

**SECTION 22 05 53**

**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe Labels
2. Valve Tags

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 DELIVERY, STORAGE AND HANDLING

A. Store materials in a dry and secure area on-site and protect against dirt and moisture damage.

B. Do not apply or install damaged materials.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Brady Corporation
2. Kolbi Pipe Marker Co.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032 inch thick, or stainless steel, 0.025 inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.
2. See sample valve-tag schedule at the end of Part 3.
3.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

## 3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

| | | Background | Lettering |
|---|---|---|---|
| 1. | Domestic Cold Water Piping: | Blue | White |
| 2. | Domestic Hot Water and Hot Water Recirculation Piping: | Red | White |
| 3. | Sanitary Waste and Storm Drainage Piping: | Black | White |
| | | Background | Lettering |
| 5. | Storm water Piping | Gray | White |

## 3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule. See sample valve-tag schedule at the end of Part 3.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Cold Water: 2 inches, round.
   b. Hot Water: 2 inches, round.

2. Valve-Tag Color:

   a. Cold Water: Natural
   b. Hot Water: Natural

3. Letter Color:

a. Cold Water: Black
b. Hot Water: Black

3.5 SAMPLE SCHEDULES

A. The following tables are examples of schedules required to be submitted by the Contractor. Example information has been included in the first row of the tables for reference only.

| VALVE-TAG SCHEDULE – DOMESTIC COLD WATER | | | | | |
|---|---|---|---|---|---|
| **VALVE NUMBER** | **VALVE TYPE** | **VALVE SIZE** | **VALVE LOCATION** | **NORMAL OPERATING POSITION** | **REMARKS** |
| CWS-1 | GATE | NPS 2 | MECHANICAL ROOM M-1 | OPEN | |
| | | | | | |

| EQUIPMENT LABEL SCHEDULE | | | | |
|---|---|---|---|---|
| **EQUIPMENT IDENTIFICATION** | **EQUIPMENT LOCATION** | **SPECIFICATION SECTION** | | **REMARKS** |
| | | **NUMBER** | **TITLE** | |
| DWBP-1 | MECHANICAL ROOM M-215 | 22 XX XX | | DOMESTIC WATER BOOSTER PUMP |
| | | | | |

**END OF SECTION**

**SECTION 22 07 00**

**PLUMBING INSULATION**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Mineral Fiber
2. Insulating Cements
3. Adhesives
4. Mastics
5. Factory-applied Jackets
6. Field-applied Jackets
7. Tapes
8. Securements

1.2 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.

B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75 deg F.

D. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogeneous material exactly 1 inch thick. Thermal resistivity's are expressed by the temperature difference in degrees F between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.

E. Density: Is expressed in lb./cu.ft.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, Thermal resistance (R Value), thickness, and jackets (both factory and field applied, if any).

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. LEED Submittal Credit EQ 4: Submit certification stating that all adhesives & sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

## 1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance for plumbing and mechanical equipment.

C. Coordinate installation and testing of heat tracing.

## 1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

1.8 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Mineral-Fiber, Preformed Pipe Insulation:
      a. Johns Manville; Micro-Lok
      b. Knauf Insulation; 1000(Pipe Insulation
      c. Owens Corning; Fiberglas Pipe Insulation
   2. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
      a. Insulco, Division of MFS, Inc.; Triple I
      b. P. K. Insulation Mfg. Co., Inc.; Super-Stik
   3. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
      a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote
   4. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement:
      a. Insulco, Division of MFS, Inc.; SmoothKote
      b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote
      c. Rock Wool Manufacturing Company; Delta One Shot
   5. Mineral-Fiber Adhesive:
      a. Childers Products, Division of ITW; CP-82
      b. Foster Products Corporation, H. B. Fuller Company; 85-20
      c. ITW TACC, Division of Illinois Tool Works; S-90/80
   6. Mineral-Fiber Adhesive:
      a. Childers Products, Division of ITW; CP-82
      b. Foster Products Corporation, H. B. Fuller Company; 85-20
      c. ITW TACC, Division of Illinois Tool Works; S-90/80
      d. Marathon Industries, Inc.; 225
   7. PVC Jacket Adhesive:
      a. Dow Chemical Company (The); 739, Dow Silicone
      b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive
      c. P.I.C. Plastics, Inc.; Welding Adhesive
      d. Red Devil, Inc.; Celulon Ultra Clear

8. Vapor-Barrier Mastic:

    a. Childers Products, Division of ITW; CP-35
    b. Foster Products Corporation, H. B. Fuller Company; 30-90
    c. Marathon Industries, Inc.; 590
    d. Vimasco Corporation; 749

9. Breather Mastic:

    a. Childers Products, Division of ITW; CP-10
    b. Foster Products Corporation, H. B. Fuller Company; 35-00
    c. Marathon Industries, Inc.; 550
    d. Vimasco Corporation; WC-1/WC-5

10. PVC Jacket:

    a. Johns Manville; Zeston
    b. P.I.C. Plastics, Inc.; FG Series
    c. Proto PVC Corporation; LoSmoke
    d. Speedline Corporation; SmokeSafe

11. ASJ Tape:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835
    b. Compac Corp.; 104 and 105
    c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF AS.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ

12. PVC Tape:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555
    b. Compac Corp.; 130
    c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape
    d. Venture Tape; 1506 CW NS

13. Bands:

    a. Childers Products; Bands
    b. PABCO Metals Corporation; Bands
    c. RPR Products, Inc.; Bands

14. Capacitor-Discharge-Weld Pins:

    a. AGM Industries, Inc.; CWP-1
    b. GEMCO; CD
    c. Midwest Fasteners, Inc.; CD
    d. Nelson Stud Welding; TPA, TPC, and TPS

15. Cupped-Head, Capacitor-Discharge-Weld Pins:

    a. AGM Industries, Inc.; CWP-1

b. GEMCO; Cupped Head Weld Pin
c. Midwest Fasteners, Inc.; Cupped Head
d. Nelson Stud Welding; CHP

16. Metal, Adhesively Attached, Perforated-Base Insulation Hangers:

a. AGM Industries, Inc.; Tactoo Insul-Hangers, Series T
b. GEMCO; Perforated Base
c. Midwest Fasteners, Inc.; Spindle

17. Insulation-Retaining Washers:

a. AGM Industries, Inc.; RC-150
b. GEMCO; R-15.
c. Midwest Fasteners, Inc.; WA-150
d. Nelson Stud Welding; Speed Clips

18. Wire:

a. C & F Wire
b. Childers Products
c. PABCO Metals Corporation
d. RPR Products, Inc.

## 2.2 INSULATION MATERIALS

A. Comply with requirements in PART 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.4 ADHESIVES

A. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
4. Color: White.
5. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 200 deg F.
3. Solids Content: 63 percent by volume and 73 percent by weight.
4. Color: White.

5. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

## 2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

## 2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions From Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
3. Color: White
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
5. Factory-fabricated tank heads and tank side panels.

## 2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches
2. Thickness: 11.5 mils
3. Adhesion: 90 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product

requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
4. Elongation: 2 percent
5. Tensile Strength: 40 lbf/inch in width
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2 inches
2. Thickness: 6 mils
3. Adhesion: 64 ounces force/inch in width. All Adhesives & Sealants (LEED EQ 4): All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.
4. Elongation: 500 percent
5. Tensile Strength: 18 lbf/inch in width

## 2.9 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015-inch-thick, 3/4-inch-wide with wing seal.
2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 3/4-inch-wide with wing seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
    b. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.

4. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates. All Adhesives & Sealants (LEED EQ 4): All adhesive

and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Wire: 0.080-inch nickel-copper alloy 0.062-inch soft-annealed, stainless steel 0.062-inch soft-annealed, galvanized steel.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:
1. Testing Agency Labels and Stamps
2. Nameplates and Data Plates
3. Sanitary Cleanouts. Storm Cleanouts are to be Insulated

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

## 3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.6 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 PIPING INSULATION SCHEDULE

A. General: Abbreviations used in the following schedules include:

1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.

B. Interior Domestic Hot Water and Recirculated Hot Water:

| PIPE SIZES (NPS) | MATERIALS | THERMAL CONDUCTIVITY, K FOR LISTED K | THICKNESS IN INCHES | VAPOR BARRIER REQ'D | FIELD-APPLIED JACKET |
|---|---|---|---|---|---|
| ALL SIZES | GLASS FIBER | .28 | 1 | NO | (P) |
| | | | | | |

NOTE: Increase insulation thickness 1/2” for pipes > 1-1/2” in systems operating between 140 deg F and 169 deg F.

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C. Interior Domestic Cold Water, condensate drains and Storm Drainage:

| PIPE SIZES (NPS) | MATERIALS | THERMAL CONDUCTIVITY, K FOR LISTED K | THICK-NESS IN INCHES | VAPOR BARRIER REQ'D | FIELD-APPLIED JACKET |
|---|---|---|---|---|---|
| 1/2 TO <1-1/2 | GLASS FIBER | .28 | 1/2 | Yes, Factory Installed | (P) |
| | | | | | |
| 1-1/2 TO <4 | GLASS FIBER | .28 | 1 | Yes, Factory Installed | (P) |
| | | | | | |

3.9 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material for all exposed pipes. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is owner/architect's option.

C. Piping, Exposed:

1. PVC, Color-Coded by System: 30 mils thick.

**END OF SECTION**

**SECTION 22 11 16**

**DOMESTIC WATER PIPING**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Domestic Water Piping inside the building.

1.2 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.5 WARRANTY

A. Provide manufacturer’s standard 1-year warranty for materials and labor, commencing on date of substantial completion.

1.6 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

A. Refer to PART 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

### 2.2 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Types K (ASTM B 88M, Types A and B), water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Compression fittings are allowed for soft copper connection sizes of 3/8” or less.

B. Hard Copper Tube: ASTM B 88, Types L (ASTM B 88M,), water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

### 2.3 VALVES

A. Bronze,, general-duty valves, and balancing valves are specified in Division 22 Section "General Duty Valves for Plumbing Piping"

## PART 3 - EXECUTION

### 3.1 EXCAVATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earthwork."

### 3.2 PIPE AND FITTING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.
   1.

C. Aboveground Domestic Water Piping: Use the following piping materials for each size range:

   1. NPS 3 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.

## 3.3 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

   1. Shutoff Duty: Use bronze ball valves for piping NPS 2-1/2 and smaller.
   2. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
   3. Drain Duty: Hose-end drain valves.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2-1/2 and smaller.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

   1. Install hose-end drain valves at low points in water mains, risers, and branches.
   2. Install stop-and-waste drain valves where indicated.

D. Install calibrated balancing valves in each hot-water circulation return branch, in the hot water return main where branches join. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."

## 3.4 PIPING INSTALLATION

A. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping," and drain valves and strainers are specified in Division 22 Section "Domestic Water Piping Specialties."

C. Install domestic water piping level without pitch and plumb.

## 3.5 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 23 Section "Basic HVAC Materials and Methods."

B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

## 3.6 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

## 3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:

1. Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

## 3.8 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

## 3.9 CLEANING AND ADJUSTING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

D. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

## 3.10 CONTRACTOR STARTUP AND REPORTING

A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

B. Perform the following steps before putting into operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use

C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

D. Check plumbing specialties and verify proper settings, adjustments, and operation.

**END OF SECTION**

**SECTION 22 11 19**

**DOMESTIC WATER PIPING SPECIALTIES**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes the following domestic water piping specialties:

***ADJUST LIST BELOW TO SUIT PROJECT.***

1. Vacuum Breakers
2. Backflow Preventers
3. Balancing Valves
4. Temperature-actuated Water Mixing Valves
5. Strainers
6. Outlet Boxes
7. Non-Freeze Wall Hydrants
8. Drain Valves
9. Water Hammer Arresters
10. Air Vents

### 1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

### 1.3 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver specialties in factory-provided packaging. Maintain packaging through shipping, storage, and handling to prevent damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored specialties from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.5 WARRANTY

A. Provide manufacturer's standard 1-year warranty for materials and labor, commencing on date of substantial completion.

1.6 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

a. Pipe-Applied, Atmospheric-Type Vacuum Breakers

1) Ames Co.
2) Cash Acme.
3) Conbraco Industries, Inc.
4) Chicago Faucet
5) FEBCO; SPX Valves & Controls
6) Watts Industries, Inc.; Water Products Div.
7) Zurn Plumbing Products Group; Wilkins Div.

b. Double-Check Backflow-Prevention Assemblies

1) Ames Co.
2) Conbraco Industries, Inc.
3) FEBCO; SPX Valves & Controls
4) Watts Industries, Inc.; Water Products Div.
5) Zurn Plumbing Products Group; Wilkins Div.

c. Copper-Alloy Calibrated Balancing Valves

1) Armstrong International, Inc.

2) ITT Industries; Bell & Gossett Div.
3) NIBCO INC.
4) TAC Americas
5) Taco, Inc.
6) Watts Industries, Inc.; Water Products Div.

d. Individual-Fixture, Water Tempering Valves

1) Conbraco Industries, Inc.
2) Lawler Manufacturing Company, Inc.
3) Leonard Valve Company
4) Powers; a Watts Industries Co.
5) Watts Industries, Inc.; Water Products Div.
6) Symmons Industries, Inc.
7) Zurn Plumbing Products Group; Wilkins Div.

e. Clothes Washer Outlet Boxes

1) Acorn Engineering Company
2) Guy Gray Manufacturing Co., Inc.
3) Symmons Industries, Inc.
4) Watts Industries, Inc.; Water Products Div.
5) Zurn Plumbing Products Group; Light Commercial Operation
6) IPS Corp.

f. Water Hammer Arresters

1) Josam Company
2) MIFAB, Inc.
3) Sioux Chief Manufacturing Company, Inc.
4) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
5) Tyler Pipe; Wade Div.
6) Watts Drainage Products Inc.
7) Zurn Plumbing Products Group; Specification Drainage Operation

## 2.2 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze
4. Inlet and Outlet Connections: Threaded
5. Finish: Rough bronze in unfinished back of house areas, chrome plated where exposed to public.

## 2.3 BACKFLOW PREVENTERS

A. Double-Check Backflow-Prevention Assemblies:

1. Standard: ASSE 1015.
2. Operation: Continuous-pressure applications, unless otherwise indicated.

3. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
4. Size: Same as pipe size
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through or vertical flow as applicable
8. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
9. .

## 2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves (2 inch and smaller):

1. Type: Y-pattern globe valve with two readout ports and memory setting indicator.
2. Body: Bronze.
3. Size: Same as connected piping, but not larger than NPS 2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

## 2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Standard: ASSE 1070/1016, thermostatically controlled water tempering valve.
2. Pressure Rating: 125 psig minimum, unless otherwise indicated.
3. Body: Bronze body with corrosion-resistant interior components.
4. Temperature Control: Adjustable.
5. Inlets and Outlet: Threaded or compression to match supplies
6. Finish: Rough or chrome-plated bronze.
7. Tempered-Water Setting: 110 deg F.

## 2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 (DN 50) and Smaller: 0.033 inch.
6. Drain: Factory-installed, hose-end drain valve.

## 2.7 OUTLET BOXES

A. Clothes Washer Outlet Boxes WB-1:

1. Mounting: Recessed.
2. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
3. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing. Include water hammer arrestors.
5. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
6. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
7. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

## 2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters: Install at all quick closing valves.

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows.
3. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
4. Provide arrestors with WB-1.

## 2.10 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.

4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Refer to Division 23 Section "Basic HVAC Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

F. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Miscellaneous Rough Carpentry." Coordinate requirements with fire rating of WB-1.
1. .

G. Install water hammer arresters in water piping according to PDI-WH 201 for all quick closing valves such as water closet flush valves.

H. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard. Comply with backflow height limitations, typically between 18" and 5' above finished floor.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.4 CLEANING AND ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

3.5 CONTRACTOR STARTUP AND REPORTING

A. Before startup, perform the following checks:

1. System tests are complete.
2. Damaged and defective specialties and accessories have been replaced or repaired.
3. Clear space is provided for servicing specialties.

B. Before operating systems, perform the following steps:

1. Close drain valves.
2. Open general-duty valves to fully open position.
3. Remove and clean strainers.
4. Verify that drainage and vent piping are clear of obstructions. Flush with water until clear.

C. Adjust operation and correct deficiencies discovered during startup.

**END OF SECTION**

**SECTION 22 13 16**

**SANITARY WASTE AND VENT PIPING**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, Tube, and Fittings
2. Special Pipe Fittings
3. Encasement for Underground Metal Piping

1.2 DEFINITIONS

A. EPDM: Ethylene-Propylene-Diene Terpolymer Rubber

B. NBR: Acrylonitrile-Butadiene Rubber

1.3 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings

C. Field quality-control inspection and test reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Flexible, Nonpressure Pipe Couplings:

a. Fernco, Inc.
b. Logan Clay Products Company (The)
c. Mission Rubber Co.
d. NDS, Inc.

2. Shielded Nonpressure Pipe Couplings:

a. Cascade Waterworks Mfg. Co.
b. Mission Rubber Co.

3. Rigid, Unshielded, Nonpressure Pipe Couplings:

a. ANACO

4. Pressure Pipe Couplings:

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.; DMD Div.
c. EBAA Iron Sales, Inc.
d. JCM Industries, Inc.
e. Romac Industries, Inc.

5. Expansion Joints:

a. EBAA Iron Sales, Inc.
b. Romac Industries, Inc.
c. Star Pipe Products; Star Fittings Div.

6. Wall-Penetration Fittings:

a. SIGMA Corp.

2.2 PIPING MATERIALS

A. Refer to PART 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

B. Flanges: ASME 16.1, Class 125, cast iron.

2.5 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
2. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
3. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
4. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.6 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Center-Sleeve Material: Stainless steel.
2. Gasket Material: Natural or synthetic rubber.
3. Metal Component Finish: Corrosion-resistant coating or material.

D. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts. Install per manufacturers recommendations based on length of piping installed.

E. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with

AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, cross-laminated PE film of 0.004-inch minimum thickness.

B. Form: Sheet or tube.

C. Color: Black or natural.

**PART 3 - EXECUTION**

3.1 EXCAVATION

A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 3 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; lead and oakum joints.
2. Copper tube, copper drainage fittings, and soldered joints.
3. Dissimilar Pipe-Material Couplings: Rigid, unshielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, soil and waste piping NPS 4 and larger shall be the following:

1. Service class, cast-iron soil pipe and fittings; lead and oakum joints.

D. Aboveground, vent piping NPS 3 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; lead and oakum joints.
2. Copper tube, copper drainage fittings, and soldered joints.
3. Dissimilar Pipe-Material Couplings: Rigid, unshielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Aboveground, vent piping NPS 4 and larger shall be the following:

1. Service class, cast-iron soil pipe and fittings; lead and oakum joints.

F. Underground, soil, waste, and vent piping NPS 4 and larger shall be the following:

1. Service Class or Extra-Heavy (where required to connect to existing), cast-iron soil piping; gaskets; and gasketed joints.

G. Aboveground sanitary-sewage force mains NPS 1-1/2 to NPS 3 shall be any of the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.

H. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:

1. Soft copper tube, Type L (Type B); wrought-copper pressure fittings; and soldered joints.
2. Push-on-joint, ductile-iron pipe; push-on-joint ductile-iron fittings; gaskets; and gasketed joints.
3. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

3.3 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Storm Drains."

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

C. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

D. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

E. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

F. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 23 Section "Basic HVAC Materials and Methods."

H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drainpipe. Straight tees, elbows, and crosses may be used on vent lines. Do not

change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing. Sleeves are still required for mechanical spaces, extending 2” above the finished floor.

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 23 Section "Basic HVAC Materials and Methods."

B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General Duty Valves for Plumbing Piping & Equipment."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.

1. Install gate for piping NPS 2 and smaller.
2. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

## 3.6 HANGER AND SUPPORT INSTALLATION

A. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

E. Install supports for vertical cast-iron soil piping every 15 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12 : 12 feet with 7/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Install supports for vertical stainless-steel piping every 10 feet.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.

2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main or sanitary manhole.
2. Sewage Pumps: To sewage pump discharge.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

## 3.9 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).
2. Sanitary Sewer, Force-Main Piping: 100 psig (690 kPa).

## 3.10 CLEANING AND ADJUSTING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

**END OF SECTION**

**SECTION 22 14 13**

**STORM DRAINAGE PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following storm drainage piping inside the building:

1. Pipe, Tube, and Fittings for Drainage and Drain Tile
2. Special Pipe Fittings
3. Encasement for Underground Metal Piping

1.3 DEFINITIONS

A. PVC: Polyvinyl Chloride Plastic

B. TPE: Thermoplastic Elastomer

1.4 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings

C. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Flexible, Nonpressure Pipe Couplings:

    a. Fernco, Inc.
    b. Logan Clay Products Company (The)
    c. Mission Rubber Co.
    d. NDS, Inc.

2. Shielded Nonpressure Pipe Couplings:

    a. Cascade Waterworks Mfg. Co.
    b. Mission Rubber Co.

3. Rigid, Unshielded, Nonpressure Pipe Couplings:

    a. ANACO

4. Pressure Pipe Couplings:

    a. Cascade Waterworks Mfg. Co.
    b. Dresser, Inc.; DMD Div.
    c. EBAA Iron Sales, Inc.
    d. JCM Industries, Inc.
    e. Romac Industries, Inc.

5. Expansion Joints:

    a. EBAA Iron Sales, Inc.
    b. Romac Industries, Inc.
    c. Star Pipe Products; Star Fittings Div.

6. Wall-Penetration Fittings:

    a. SIGMA Corp.

## 2.2 PIPING MATERIALS

A. Refer to PART 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

## 2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

B. Flanges: ASME 16.1, Class 125, cast iron.

2.5 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
2. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
3. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
4. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type B), water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.6 DRAINTILE PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent, with perforations on one half of pipe.

B. Perforated, Clay Pipe and Fittings: ASTM C 700, Standard-Strength and Extra-Strength classes, unglazed, socket-and-spigot ends, for closed joints.

1. Gaskets: ASTM C 425, rubber.

2.7 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Center-Sleeve Material: Stainless Steel
2. Gasket Material: Natural or Synthetic Rubber
3. Metal Component Finish: Corrosion-resistant Coating or Material

E. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

F. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

## 2.8 SOIL MATERIALS FOR DRAINTILE

A. Impervious Fill: Clayey gravel and sand mixture capable of compacting to dense state.

B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D 448, coarse aggregate, Size No. 57, with 100 percent passing 1-1/2-inch sieve and not more than 5 percent passing No. 8 sieve.

C. Filtering Material: Evenly graded mixture of natural or crushed gravel or crushed stone and natural sand, with 100 percent passing 1-1/2-inch sieve and 0 to 5 percent passing No. 50 sieve.

## 2.9 FILTER FABRIC FOR DRAINTILE

A. Woven geotextile filter fabric, in 1 or more layers, for minimum total weight of 3 oz./sq. yd. Include fabric covering for entire length of tile installation. Coordinate and match existing installation of drain-tile to new repairs shown on plan.

## 2.10 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, cross-laminated PE film of 0.004-inch minimum thickness.

B. Form: Sheet or tube.

C. Color: Black

**PART 3 - EXECUTION**

3.1 EXCAVATION

A. Refer to Division 31 Section “Earthwork”, for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; and lead and oakum joints.
2. Copper tube, copper drainage fittings, and soldered joints.

C. Aboveground, storm drainage piping NPS 8 and larger shall be the following:

1. Service class, cast-iron soil pipe and fittings; and lead and oakum joints.

D. Underground storm drainage piping NPS 6 and smaller shall be the following:

1. Extra-heavy (where required to match existing) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints. Use ductile iron material in areas where piping is in close proximity to the water service piping. Coordinate with Civil.

E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Extra-Heavy (where required to match existing) Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints. Use ductile iron material in areas where piping is in close proximity to the water service piping. Coordinate with Civil.

F. Aboveground storm drainage force mains NPS 1-1/2 to NPS 4 shall be any of the following:

1. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.

G. Draintile piping, use the following:

1. For new installations, use perforated PVC pipe.
2. For repair or renovation of existing installations, use perforated clay tile to match existing materials.

## 3.3 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 23 Section “Basic HVAC Materials and Methods”.

B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section “Drainage Piping Specialties”.

C. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

D. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 23 Section "Basic HVAC Materials and Methods."

F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105 where indicated on drawings.

G. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

H. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

I. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

J. Install force mains at elevations indicated.

K. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

L. Install underground PVC storm drainage piping according to ASTM D 2321. Drain-tile systems only.

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

## 3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 23 Section "Basic HVAC Materials and Methods."

B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

E. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

## 3.5 DRAINTILE INSTALLATION

A. General installation procedure as follows:

1. Excavation.
2. Placement of fabric.
3. Placement of filtering fill/gravel.
4. Placement of piping.
5. Placement of filtering fill/gravel.
6. Complete fabric installation and overlap.
7. Integration of foundation wall drainage mats to foundation drainage system as instructed by manufacturers.
8. Complete backfill procedure.

B. Impervious Fill at Footings: Place impervious fill material on subgrade adjacent to bottom of footing after concrete footings have been cured and forms removed. Place and compact impervious fill to dimensions indicated but not less than 6 inches deep and 12 inches wide.

C. Filtering Material: Place supporting layer of filtering material over compacted subgrade where drainage pipes are to be laid to depth indicated or, if not indicated, to compacted depth of not less than 6 inches.

D. Drainage Fill: Place fill over drain piping after satisfactory testing and covering with filtering material. Cover piping to width of at least 6 inches on each side and above top of pipe to within 12 inches of finish grade. Place fill material in layers not exceeding 3 inches in loose depth, and compact each layer placed.

E. Fill to Grade: Place impervious fill material over compacted drainage fill. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish elevations and slope away from building.

## 3.6 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section General Duty Valves for Plumbing Piping & Equipment.

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install gate valve for piping NPS 2 and smaller.
2. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.

## 3.7 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section Hangers and Supports for Plumbing Piping and Equipment. Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section Hangers and Supports for Plumbing Piping and Equipment.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

## 3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main or storm manhole.
2. Sump Pumps: To sump pump discharge.

## 3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

## 3.10 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated: Test all piping per local AHJ requirements. In the absence of AHJ testing requirements, proceed with the following criteria:

1. Storm Drainage Piping: 10-foot head of water.
2. Storm Drainage, Force-Main Piping: 100 psig.

## 3.11 CLEANING AND ADJUSTING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

**END OF SECTION**

# SECTION 22 14 23

# DRAINAGE PIPING SPECIALTIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes the following drainage piping specialties:

***ADJUST LIST BELOW TO SUIT PROJECT.***

1. Cleanouts
2. Floor Drains
3. Roof Flashing Assemblies
4. Roof Drains
5. Miscellaneous Drainage Piping Specialties
6. Flashing Materials

### 1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PUR: Polyurethane plastic.

G. PVC: Polyvinyl chloride plastic.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include specialties within on coordinated shop drawings.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

1.5 DELIVERY, STORAGE AND HANDLING.

A. Deliver specialties in factory-provided packaging. Maintain packaging through shipping, storage, and handling to prevent damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored specialties from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

1.6 WARRANTY

A. Provide manufacturer's standard 1-year warranty for materials and labor, commencing on date of substantial completion.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate size and location of roof penetrations.

**PART 2 - PRODUCTS**

1. Cast-Iron Floor Drains

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Zurn Plumbing Products Group; Specification Drainage Operation

2. Roof Drains

a. Cast-Iron:

1) Josam Company; Josam Div.
2) MIFAB, Inc.
3) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
4) Tyler Pipe; Wade Div.
5) Zurn Plumbing Products Group; Specification Drainage Operation

B. Metal Floor Cleanouts FCO:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.

C. Cast-Iron Wall Cleanouts WCO:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.

2.2 CHA STANDARD FLOOR DRAINS AND CLEANOUTS

A. Floor Drain FD-1: Where plumbing specialties of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.

2. Applicable Standard: ASME A112.21.1M
3. Body Material: Cast iron.
4. Seepage Flange: Required.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Sediment Bucket: Not required.
8. Top or Strainer Material: Bronze or Stainless Steel.
9. Top of Body and Strainer Finish: Polished brass or Stainless Steel.
10. Top Shape: Round.
11. Dimensions of Top or Strainer: 6”
12. Top Loading Classification: Light Duty.
13. Funnel: Not required.
14. Funnel Dimensions: Not required.
15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.
17. Trap Features: Cleanout

B. Floor Drain FD-2: Where plumbing specialties of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
2. Applicable Standard: ASME A112.21.1M.
3. Body Material: Cast iron.
4. Seepage Flange: Required.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Sediment Bucket: Required.
8. Top or Strainer Material: Cast iron.
9. Top of Body and Strainer Finish: Rough brass or Cast Iron.
10. Top Shape: Round.
11. Dimensions of Top or Strainer: 8”
12. Depth of Drain Body: 3 inches
13. Top Loading Classification: Heavy Duty.
14. Funnel: Not required.
15. Funnel Dimensions: Not required.
16. Trap Material: Cast iron.
17. Trap Pattern: Deep-seal P-trap.

## 2.3 CHA STANDARD ROOF DRAINS

A. Roof Drain RD-1: Where plumbing specialties of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
2. Applicable Standard: ASME A112.21.2M.
3. Body Material: Cast iron.
4. Combination Flashing Ring and Gravel Stop: Required.

5. Outlet: Bottom.
6. Dome Material: Cast iron.
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
9. Sump Receiver: Required.
10. Diameter of Body: 16-inch.

B. Roof Deck Drain DD-1: Where plumbing specialties of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
2. Applicable Standard: ASME A112.21.2M.
3. Body Material: Cast iron.
4. Outlet: Bottom.
5. Strainer Material: Cast iron w/bronze veneer top. .
6. Extension Collars: See Architectural floor details.
7. Underdeck Clamp: As required.
8. Sump Receiver: As required.
9. Diameter of Body: 14-inch.
10. Coordinate options with fluid applied membrane floor at deck surface.

## 2.4 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

2.5 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft.
2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

C. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

D. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section Sheet Metal Flashing and Trim.

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.5 CONTRACTOR STARTUP AND REPORTING

A. Perform the following final checks before startup:

1. Verify that specified tests of piping systems are complete.

**END OF SECTION**

**SECTION 22 14 29**

**SUMP PUMPS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following sump pumps and accessories, inside the building, for building storm drainage systems:

1. Submersible sump pumps.
2. Sump pump basins and pits.

1.3 SUBMITTALS

A. Product Data: For each type and size of sump pump specified. Include certified performance curves with operating points plotted on curves, and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For each sump pump to include in emergency, operation, and maintenance manuals.

D. Startup Reports: Submit reports documenting the activities required to be performed in PART 3. These reports are to be submitted two weeks after the startup is completed.

E. Training Reports: Submit reports on training documenting dates and attendance.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sump pumps and are based on the specific system indicated. Refer to Division 01 Section “Product Requirements”.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of concrete pits. Concrete, reinforcement, and formwork requirements are specified in Division 03.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Submersible Sump Pumps:

a. Zoeller Company
b. Metropolitan Pump Co.
c. Weil Pump Co.
d. Hydramatic

2.2 SUBMERSIBLE SUMP PUMPS

A. Description: Factory-assembled and -tested, simplex, single-stage, centrifugal, end-suction, submersible, direct-connected sump pumps complying with UL 778 and HI 1.1-1.2 and HI 1.3 for submersible sump pumps.

B. Casing: Cast iron; with cast-iron inlet strainer, legs that elevate pump to permit flow into impeller, and vertical discharge with companion flange for piping connection.

C. Impeller: ASTM A 532/A 532M, abrasion-resistant cast iron; statically and dynamically balanced, semiopen nonclog design, overhung, single suction, keyed and secured to shaft.

D. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings and double-mechanical seals.

E. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection; three-conductor waterproof power cable of length required, and with grounding plug and cable-sealing assembly for connection at pump. Comply with requirements in Division 23 Section Common Motor Requirements for HVAC Equipment.

1. Moisture-Sensing Probe: Internal moisture sensor with moisture alarm.

F. Pump Discharge Piping: Factory or field fabricated, copper tube.

G. Basin or Pit Cover: Cast iron or steel with bituminous coating and strong enough to support controls. See Part 2 "Sump Pump Basins and Pits" Article for other requirements.

H. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with float, float rod, and rod buttons. For simplex systems only.

## 2.3 SUMP PUMP PITS

A. Description: Concrete pit with sump, pipe connections, curb frame, and separate cover.

B. Sump: Construct of watertight, cast-in-place, reinforced concrete with sidewall openings for pipe connections. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section Cast-in-Place Concrete.

1. Pipe Connections: Sleeved openings large enough for mechanical sleeve seals for drainage piping. Sleeves and mechanical sleeve seals are specified in Division 23 Section Basic HVAC Materials and Methods, and drainage piping is specified in Division 22 Section Facility Storm Drainage Piping.

C. Curb Frame and Cover:

1. Curb Frame Material: Galvanized steel or steel with bituminous coating.

a. Pattern: Angle-cross-section shape with flat top surface.

2. Cover: Fabricate with openings having gaskets, seals, and bushings, for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

a. Material: Cast iron or steel with bituminous coating.
b. Reinforcement: Steel or cast iron, capable of supporting foot traffic for pits installed in foot-traffic areas.

## 2.4 BUILDING AUTOMATION SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in of plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

### 3.2 CONCRETE

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section “Basic HVAC Materials and Methods”.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

### 3.3 SUMP PUMP INSTALLATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section “Earthwork”.

B. Install sump pumps according to applicable requirements in HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Set submersible sump pumps on basin or pit floor. Make direct connections to storm drainage piping.

E. Install sump pump basins and connect to drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

F. Construct sump pump pits and connect to drainage piping. Set pit curb frame recessed in and anchored to concrete. Fasten pit cover to pit curb flange. Install cover so top surface is flush with finished floor.

G. Support piping so weight of piping is not supported by pumps.

## 3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "Facility Storm Drainage Piping". Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to sump pumps to allow service and maintenance.

C. Connect storm drainage piping to pumps. Install discharge piping equal to or greater than size of pump discharge piping. Refer to Division 22 Section "Facility Storm Drainage Piping".

1. Install flexible connectors adjacent to pumps in discharge piping.
2. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for drainage piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems".

E. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical Systems".

## 3.5 STARTUP SERVICE

A. Startup service includes the testing, inspections and startup test reports. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify bearing lubrication.
3. Disconnect couplings and check motors for proper direction of rotation.
4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
5. Verify that pump controls are correct for required application.

B. Start pumps without exceeding safe motor power:

1. Start motors.
2. Open discharge valves slowly.
3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.

1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

## 3.6 CLEANING AND ADJUSTING

A. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.

## 3.7 DEMONSTRATION AND TRAINING

A. Train the CHA's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining pumps. The training will occur after the startup report has been provided to the CHA. Refer to Division 01 Section "Demonstration and Training."

B. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data." All required and recommended maintenance will be reviewed as well as operational troubleshooting.

**END OF SECTION**

**SECTION 22 40 00**

**PLUMBING FIXTURES**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes the following conventional plumbing fixtures and related components:
   1. Commercial Sinks
   2. Service Sinks
   3. Electric Water Coolers

### 1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Drinking Fountain: Fixture that can be approached and used by people with disabilities.

C. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

D. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

E. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

F. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

G. FRP: Fiberglass-reinforced plastic.

H. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

I. PMMA: Polymethyl methacrylate (acrylic) plastic.

J. PVC: Polyvinyl chloride plastic.

K. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

L. Tepid: Moderately warm.

1.3 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"**;** Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M
2. Plastic Laundry Trays: ANSI Z124.6
3. Plastic Mop-Service Basins: ANSI Z124.6
4. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M
5. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1
6. Stainless-Steel Commercial, Handwash Sinks: NSF 2 Construction
7. Stainless-Steel Sinks: ASME A112.19.3
8. Vitreous-China Fixtures: ASME A112.19.2M
9. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5

10. Water-Closet, Flushometer Tank Trim: ASSE 1037

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025
4. Faucets: ASME A112.18.1
5. Hose-Connection Vacuum Breakers: ASSE 1011
6. Hose-Coupling Threads: ASME B1.20.7
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001
8. NSF Potable-Water Materials: NSF 61
9. Pipe Threads: ASME B1.20.1
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951
11. Supply Fittings: ASME A112.18.1
12. Brass Waste Fittings: ASME A112.18.2

I. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016
3. Faucets: ASME A112.18.1
4. Hand-Held Showers: ASSE 1014
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445
6. Hose-Coupling Threads: ASME B1.20.7
7. Manual-Control Antiscald Faucets: ASTM F 444
8. Pipe Threads: ASME B1.20.1
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001
2. Brass and Copper Supplies: ASME A112.18.1
3. Dishwasher Air-Gap Fittings: ASSE 1021
4. Manual-Operation Flushometers: ASSE 1037
5. Brass Waste Fittings: ASME A112.18.2
6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430
2. Dishwasher Air-Gap Fittings: ASSE 1021
3. Flexible Water Connectors: ASME A112.18.6
4. Floor Drains: ASME A112.6.3

5. Grab Bars: ASTM F 446
6. Hose-Coupling Threads: ASME B1.20.7
7. Off-Floor Fixture Supports: ASME A112.6.1M
8. Pipe Threads: ASME B1.20.1
9. Plastic Toilet Seats: ANSI Z124.5
10. Supply and Drain Protective Shielding Guards: ICC A117.1

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 2 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Flushometer Tank, Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than 2 of each type.
6. Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.
7. Toilet Seats: Equal to 5 percent of amount of each type installed.
8. Filter Cartridges for drinking fountains: Equal to 5 percent of amount installed for each type and size indicated, but no fewer than 2 of each.
9. Shower Heads: TBD, stored at central warehouse
10. Bathroom Faucet Aerators: TBD, stored at central warehouse
    * faucets should be specified so as to standardize aerators across the portfolio.
11. Kitchen Faucet Aerators: TBD, stored at central warehouse
    * faucets should be specified so as to standardize aerators across the portfolio.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Sink Faucets:

1. American Standard Companies, Inc.
2. Chicago Faucets
3. Symmons
4. Kohler Co.
5. Moen, Inc.- Commercial
6. T & S Brass and Bronze Works, Inc.
7. Zurn Plumbing Products Group; Commercial Brass Operation
8. Columbia

B. Protective Shielding Pipe Covers:

1. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products
2. McGuire Manufacturing Co., Inc.
3. Plumberex Specialty Products Inc.
4. TCI Products
5. TRUEBRO, Inc.

C. Fixture Supports

1. Josam Company
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Zurn Plumbing Products Group; Specification Drainage Operation

D. Commercial Sinks:

1. Advance Tabco
2. Elkay Manufacturing Co.
3. Just Manufacturing Company
4. Columbia

E. Service Sinks:

1. Columbia
2. Elkay
3. Fiat

F. Water-Tempering Equipment:

1. Bradley Corporation
2. Haws Corporation
3. Lawler Manufacturing Co., Inc.
4. Leonard Valve Company
5. Powers, a Watts Industries Co.

G. Mop-Service Basin MS-1: Where plumbing fixtures of this designation are indicated, provide products complying with the following:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in paragraph 2.1.
2. Fixture Dimensions: 20 inches x 30 inches x less than 6.5” deep (ADA compliant)
3. Mounting: Wall
4. Material: Stainless Steel
5. Faucet: Widespread, cast brass with supplies on 8-inch centers.
6. Faucet Mounting: Panel mounted.
7. Faucet Components: Include the following:

    a. Finish: Polished chrome.
    b. Handles: Dual wrist blade lever.
    c. Supply Stops: Integral, in shanks.
    d. Spout: gooseneck

e. Wall Brace: Assembly with wall bracket and support to faucet spout. Install supports per manufacturers recommendations.

8. Drain: 2-inch NPS with grid strainer.
9. P-Trap: 2-inch NPS drainage piping.
10. Supplies: 1/2-inch NPS copper tubing with ball valve.

H. Commercial Sinks, KS-1:

1. Description: Two-compartment, counter-mounting, stainless-steel counter mounted commercial sink.

*CAUTION: VERIFY THAT SELECTED SINK COMPARTMENTS AND DRAINS ARE COMPATIBLE.*

a. Overall Dimensions: See plans
b. Metal Thickness: 18 Gauge
c. Compartment:
   1) Dimensions: See plans
   2) Drain: Grid with NPS 1-1/2 tailpiece and twist drain
      a) Location: Centered in compartment

d. Sink Faucets:
   1) Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a) American Standard Companies, Inc.
      b) Toto
      c) Symmons
      d) Chicago Faucets
      e) Kohler Co.
      f) Moen, Inc.- Commercial
      g) Zurn Plumbing Products Group; Commercial Brass Operation

   2) Description: Kitchen faucet with spray, one-hole fixture. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
      a) Body Material: Commercial, solid brass.
      b) Finish: Polished chrome plate .
      c) Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.
      d) Mixing Valve: Single control.
      e) Backflow Protection Device for Hose Outlet: Required.
      f) Centers: Single hole.
      g) Mounting: Deck.
      h) Handle(s): Lever.
      i) Inlet(s): NPS 3/8 plain-end tubing.
      j) Spout Type: Swivel gooseneck.
      k) Spout Outlet: Hose thread.
      l) Vacuum Breaker: Required.
      m) Operation: Non-compression, manual, Sensor.
      n) Drain: Grid.

I. Commercial Sinks, SK-1:

1. Description: One-compartment, wall-mounting, stainless-steel commercial sink.

***CAUTION: VERIFY THAT SELECTED SINK COMPARTMENTS AND DRAINS ARE COMPATIBLE.***

a. Overall Dimensions: See plans
b. Metal Thickness: 16 Gauge.
c. Compartment:
   1) Dimensions: See plans
   2) Drain: Grid with NPS 1-1/2 tailpiece and twist drain
      a) Location: Centered in compartment

d. Sink Faucets:
   1) Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings. Faucet is furnished with the sink in a combo package.

   2) Description: Laundry tray faucet. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
      a) Body Material: Commercial, solid brass.
      b) Finish: Polished chrome plate.
      c) Maximum Flow Rate: 2.0 gpm, unless otherwise indicated.
      d) Mixing Valve: Two-lever handle.
      e) Backflow Protection Device for Hose Outlet: Not required.
      f) Centers: 8 inches.
      g) Mounting: Back/wall
      h) Handle(s): Wrist blade, 4 inches
      i) Inlet(s): NPS 3/8 plain-end tubing.
      j) Spout Type: Swivel gooseneck.
      k) Spout Outlet: Aerator.
      l) Vacuum Breaker: Not required.
      m) Operation: Non-compression, manual.
      n) Drain: Grid.
      o) Wall mounting bracket: Required.

## 2.2 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

## 2.3 ELECTRIC WATER COOLER

A. Electric Water Coolers EWC-1: Wall mounted bi-level w/ bottle filler

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. Elkay
    b. Haws
    c. Halsey
    d. Murdock

2. Standards:

    a. Comply with NSF 61 and NSF 372.
    b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
    c. Comply with ICC A117.1.

3. Cabinet: Bi-level with two attached cabinets.
4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
5. Control: Push bar
6. Bottle Filler: Sensor activation with automatic shutoff timer. Fill rate 0.5 to 1.5 gpm
7. Drain: Grid with NPS 1-1/4 tailpiece.
8. Supply: NPS 3/8 with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
10. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate. Include filter on bottle filler portion of EWC-1.
11. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

    a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

12. Capacities and Characteristics:

    a. Cooled Water:
    b. Ambient-Air Temperature: 90 deg F .
    c. Inlet-Water Temperature: 80 deg F.
    d. Cooled-Water Temperature: 50 deg F.
    e. Electrical Characteristics:
        1) Volts: 120-V ac.
        2) Phase: Single.
        3) Hertz: 60.

13. Support: Type II Water Cooler Carrier

14. Water Cooler Mounting Height: See Architectural.

B. Type II Water Cooler Carrier:

1. Provide products from one of the following manufacturers:

a. Zurn

b. Josam

c. JrSmith

d. Mifab

2. Standard: ASME A112.6.1M.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install wall-mounting fixtures with tubular waste piping attached to supports.

D. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

E. Install counter-mounting fixtures in and attached to casework.Install fixtures level and plumb according to roughing-in drawings.

F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section General Duty Valves for Plumbing Piping & Equipment.

G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

H. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

I. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

J. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

K. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

L. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install shower flow-control fittings with specified maximum flow rates in shower arms.

N. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

O. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 23 Section Basic HVAC Materials and Methods.

P. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section Joint Sealants.

## 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section Grounding and Bonding for Electrical Systems.

D. Connect wiring according to Division 26 Section Conductors and Cables for Electrical Systems.

E. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment.

F. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.

## 3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

## 3.5 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

## 3.6 CLEANING AND ADJUSTING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

C. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

D. Operate and adjust disposers and controls. Replace damaged and malfunctioning units and controls.

E. Adjust water pressure at faucets to produce proper flow and stream.

F. Replace washers and seals of leaking and dripping faucets and stops.

**END OF SECTION**

**SECTION 23 05 13**

**COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, EC Motors and squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

### 1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

## PART 2 - PRODUCTS

### 2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

### 2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300-feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with

indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Class B.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 EC MOTOR

A. Motor to be an electronic commutation (EC) motor specifically designed for direct drive fan applications.
1. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase.
2. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor.
3. Motor shall be speed controllable down to 20% of full speed (80% turndown).
4. Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal **as scheduled**.
5. Motor shall be a minimum of 85% efficient at all speeds.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION**

**SECTION 23 05 15**

**MOTORS VARIABLE FREQUENCY CONTROLLERS**

## PART 1 - GENERAL

### 1.1 DESCRIPTION

A. This specification is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.

B. The drive manufacturer shall supply the drive and all necessary controls as herein specified.

C. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer unless otherwise indicated in specifications.

### 1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 23 and 26 apply to this section.

### 1.3 DEFINITIONS

A. Acronyms:

1. BAS: Building Automation System
2. DC: Direct current
3. DB: Dry bulb
4. EMS: Energy Management System
5. IEEE: Institute of Electrical and Electronic Engineers
6. IGBT: Integrated gate bipolar transistor
7. HVAC: Heating, ventilation and cooling
8. LAN: Local area network
9. LCP: Local Control Panel
10. NEMA: National Electrical Manufacturers Association
11. NFPA: National Fire Protection Association
12. O&M: Operations and Maintenance
13. OSHA: Occupational Safety and Health Administration
14. PID: Control action, proportional plus integral plus derivative
15. PWM: Pulse-width modulated
16. UL: Underwriters Laboratories
17. WB: Wet bulb
18. VFD: Variable frequency drive

19. AFD: Adjustable frequency drive
20. VFC: Variable frequency controller
21. AFC: Adjustable frequency controller
22. VSD: Variable speed drive.
23. ASD: Adjustable speed drive
24. VSC: Variable speed controller
25. ASC: Adjustable speed controller

B. The terms VFD, AFD, VFC, AFC, VSD, ASD, VSC and ASC, as they may appear in the contract documents, all refer to the same devices.

1.4 SUBMITTALS

A. Schedule: Provide a schedule of VFDs that include the following:

1. Unit tags (VFD-1, VFD-2, etc, if shown on schedule)
2. Device or equipment being controlled (AHU1-SF, CHWP-2, etc.)
3. Design voltage (from schedules) and rated voltage of VFD from manufacturer
4. Design amperage (from schedules, if provided) and rated amperage of VFD from manufacturer
5. Design horsepower (from schedules) and rated horsepower of VFD from manufacturer
6. Minimum short circuit rating of VFD
7. Electrical power accessories including fuses, circuit breakers, disconnects, bypasses, etc.
8. BAS interface protocol (see “Coordination with BAS” below)

B. Letter of Coordination: Provide a letter of coordination with the BAS Provider (see “Coordination with BAS” below)

C. Physical Data: For each size of VFD include the following information:

1. Dimensional drawings including electronic bypass and any other accessories
2. Mounting arrangements
3. Location for conduit entries
4. Shipping and operating weights
5. Required clearances and service space around equipment.

D. Wiring Diagrams: For each size of VFD include the following information:

1. Power schematic wiring
2. Control schematic wiring

E. Features: Provide a list of VFD features, technical data, and capabilities.

F. Protocol Interface Points:

1. Provide a list of all read-write and read only points available through the VFD protocol interface.
2. Provide any software, hardware or paperwork that the contractor installing the BAS will require in order to accomplish the interface.

G. Qualification Data: Include the following information (described in greater detail in section “Quality Assurance” below):

1. Manufacture’s qualifications
2. Testing agency qualifications
3. Compliance with NFPA, UL, and IEEE guidelines

H. Operation and Maintenance Data: In addition to standard O&M manuals, include the following:

1. Routine maintenance requirements for VFDs and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

I. Harmonic Analysis:

1. Obtain the electrical system one-line diagram from the contract document.
2. Provide a harmonic analysis demonstrating that the proposed VFDs (along with harmonic mitigation equipment provided) conforms with IEEE 519-2014, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems”

J. Field quality-control test reports (not part of initial submittal):

1. Provide field quality-control test reports 2 weeks after startup is completed.

## 1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: It is required that the drive manufacturer:

1. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
2. Have an existing sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.
3. Have an existing independent service organization.
4. Have been engaged in the production of this type of equipment for a minimum of ten years

B. UL Listed: VFDs and options shall be UL listed as a complete assembly. VFDs that require the customer to supply external fuses for the VFD to be UL listed are not acceptable.

C. Components and Installation: For projects located within the City of Chicago, comply with the City of Chicago Building Code.

D. IEEE 519-2014 Compliance: Comply with IEEE 519-2014 “Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems”.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside drives; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 32°F to 104°F
2. Relative Humidity: Less than 90 % (non-condensing)
3. Altitude: Not exceeding 3,300 feet

B. Outdoor Conditions: Winter -10°F DB, Summer 95°F DB / 75°F WB

1.8 COORDINATION WITH TRADES

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 COORDINATION WITH BAS

A. The VFDs are required to be interfaced with the Building Automatic System (BAS). Provide all devices, hardware, programming, startup and commissioning required to establish this interface.

B. Prior to submitting in accordance with Part 1 of this section:

1. Communication Between Contractors: Establish communication via phone call or e-mail with BAS provider.
2. Interface Protocol Determination: Determine an interface protocol (BACnet/IP, BACnet/Ethernet, BACnet/MS/TP, LonWorks, Modbus, etc.) that is mutually acceptable to both you and the BAS provider. Note: If an interface protocol cannot be determined that is acceptable to both you and the BAS provider, make this fact known through proper channels.

3. Written Statement of Coordination: Include a written statement entitled "Coordination of Interface Protocol with BAS Provider" documenting:

    a. BAS provider (company name)
    b. Person at the BAS provider with whom the coordination took place
    c. Time and date of coordination
    d. Interface protocol that was mutually agreed upon

C. Provide a startup technician on-site during the establishment of the interface. Coordinate this activity with the BAS installer.

1.10 WARRANTY

A. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment.

B. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following (Note: As noted above, all drives on the project shall be provided by a single manufacturer):

1. ABB Power Distribution, Model ACH550
2. Danfoss North America, Model VLT-HVAC-FC100
3. Yaskawa Electric America, Model P7

2.2 VARIABLE FREQUENCY DRIVES

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus or minus 10 % or as indicated on equipment schedules
2. Input Frequency Tolerance: 50/60 Hz, plus or minus 6 %
3. Minimum Efficiency: 96 percent at 60 Hz, full load
4. Minimum Displacement Primary-Side Power Factor: 96 %
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds
6. Starting Torque: 100 percent of rated torque or as indicated
7. Speed Regulation: Plus or minus 1 percent

E. Internal Adjustability Capabilities:

1. Minimum Speed: 5% to 50% of maximum RPM
2. Maximum Speed: 50% to 100% of maximum RPM
3. Acceleration: Full stop to full speed acceleration limit adjustable between 0 and 1,800 seconds
4. Deceleration: Full speed to full stop deceleration limit adjustable between 0 and 1,800 seconds
5. Current Limit: 50% to a minimum of 110% of maximum rating
6. Adjustable Carrier Frequencies: The VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.

F. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors
2. Under-voltage trip
3. Over-voltage trip
4. Inverter over-temperature trip
5. Inverter over-current trips
6. Inverter overload trips
7. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance
8. Notch Filter: To prevent operation of the drive-motor-load combination at a natural frequency of the combination
9. Instantaneous line-to-line and line-to-ground overcurrent trips
10. Loss-of-phase protection
11. Reverse-phase protection
12. Short-circuit protection
13. Motor over-temperature fault

G. Control Features:

1. Automatic Reset/Restart: Attempts three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to drive, motor, or load.
2. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

3. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
4. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
5. Setpoint Control: The VFD shall have an inherent dual setpoint PID controller. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
6. Floating Point Control: The VFD shall be capable of increasing and decreasing speed based on response to contact closures.
7. Safety Circuit: The VFD shall have a safety circuit (a.k.a. Run Permissive Circuit) to ensure the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.

H. Power Quality Control:

1. Input Line Conditioning: DC bus link reactors
2. VFD Output Filtering: Line inductors

I. Local Control Panel (LCP):

1. The front of the VFD shall have a local control panel (LCP) that will function as a complete interface for operation and programming of the VFD.
2. The LCP shall be detachable, and the VFD shall continue to function when the LCP has been detached.
3. Through the use of an extension cable, the LCP shall be able to be mounted remotely.
4. Operating programming data shall be displayed on an LCD screen. During normal operation, the LCD shall display up to three (3) operating values simultaneously. The following information shall be available:

    a. Output frequency (Hz)
    b. Motor speed (rpm)
    c. Motor status (running, stop, fault)
    d. Motor current (amperes)
    e. Motor torque (percent)
    f. Fault or alarming status (code)
    g. PID feedback signal (percent)
    h. DC-link voltage (VDC)
    i. Set-point frequency (Hz)
    j. Motor output voltage (V)

5. LED status lights shall display the following parameters:

    a. VFD Power ON
    b. VFD Warning
    c. VFD Alarm

6. The LCP shall have HAND/OFF/AUTO buttons for direct control of the VFD

J. Control Signal Inputs:

1. Discrete Inputs: Provide a minimum of 6 programmable discrete inputs
2. Analog Inputs: Provide a minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) with the capability to accept any of the following speed-setting input signals from the BAS or other control systems:

   a. 0-5, 0-10, or 2-10 Vdc
   b. 0-20 or 4-20 mA
   c. Keypad display for local hand operation

K. Control Signal Outputs:

1. Analog Outputs: A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

   a. Output frequency (Hz)
   b. Output current (load)
   c. DC-link voltage (Vdc)
   d. Motor torque (percent)
   e. Motor speed (RPM)
   f. Set-point frequency (Hz)

2. Discrete Outputs: A minimum of 2 dry circuit relay outputs (120-Vac, 1 amp) for remote indication of the following:

   a. VFD general alarm
   b. Over temperature alarm
   c. Over current alarm
   d. VFD run status
   e. Motor run status
   f. Set-point speed reached
   g. PID high- or low-speed limits reached

3. Safety Circuit: Provide a digital input, separate from the enable input, requiring a contact closure before allowing the VFD to start

L. Bypass and Disconnect Switch:

1. Provide electronic 3-contactor bypass consisting of:

   a. Door interlocked main fused disconnect padlockable in the OFF position
   b. Built-in motor starter
   c. Four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors.
      1) In the DRIVE position, the motor is operated at an adjustable speed from the VFD
      2) In the OFF position, the motor and VFD are disconnected

3) In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed
4) In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass.

2. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode

2.3 ENCLOSURES

A. Indoors: Provide NEMA 250, Type 1

B. Outdoors: NEMA 3R with the following features/accessories:

1. Rainproof enclosure
2. Thermostatically controlled heating element
3. Thermostatically controlled cooling fan

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation

C. Proceed with installation only after unsatisfactory conditions have been corrected

3.2 APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load

B. Select horsepower rating of drives to suit motor controlled

3.3 INSTALLATION

A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

## 3.4 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26.

## 3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed drive element, bus, and component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Reports: Prepare written reports certified by testing organization of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made. Harmonic compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 41 or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect drives, wiring, components, connections, and equipment installation. Test and adjust drives, components, and equipment
2. Assist in field testing of equipment including pretesting and adjusting of solid-state drives
3. Report results in writing

## 3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges

## 3.7 CLEANING

A. Remove paint splatters and other spots, dirt and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally using methods and materials as recommended by manufacturer.

## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency drives. Refer to Division 1 Section "Testing and Inspection."

**END OF SECTION**

**SECTION 23 05 16**

**EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Flexible-hose packless expansion joints.
2. Grooved-joint expansion joints.
3. Alignment guides and anchors.
4. Pipe loops and swing connections.

### 1.3 ACTION SUBMITTALS

A. Delegated-Design Submittal: For each expansion joint, loop, swing connection, anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
1. Provide product data for for each type of product that is used.
2. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
3. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
4. Alignment Guide Details: Detail field assembly and attachment to building structure.
5. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

### 1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

### 1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints:

1. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
2. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
3. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

    a. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.

4. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded or flanged end connections.

    a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

5. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.

    a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.

6. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged or welded end connections.

    a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.

7. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged or welded end connections.

    a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

## 2.3 GROOVED-JOINT EXPANSION JOINTS

A. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

B. Standard: AWWA C606, for grooved joints.

C. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

D. Couplings: Quantity as determined by manufacturer,, flexible type for steel-pipe dimensions. Include ferrous housing sections, ethylene-propylene-diene terpolymer rubber gasket suitable for cold and hot water, and bolts and nuts.

## 2.4 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Stud: Threaded, zinc-coated carbon steel.
    b. Expansion Plug: Zinc-coated steel.
    c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
    c. Washer and Nut: Zinc-coated steel.

## PART 3 - EXECUTION

### 3.1 EXPANSION JOINT INSTALLATION

A. Design and install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install grooved-joint expansion joints to grooved-end steel piping.

### 3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Design and install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Design and connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Design and connect risers and branch connections to equipment with at least four pipe fittings, including tee in riser.

D. Design and connect mains and branch connections to equipment with at least[four pipe fittings, including tee in main.

### 3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Design and Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Design and install guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Design and attach guides to pipe, and secure guides to building structure.

D. Design and install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Design anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Design anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Design, fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

H. Coordinate alignment guides and anchors with structure.

**END OF SECTION**

**SECTION 23 05 17**

**SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings (Not for Use as a Floor Drain).
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

B. Related Requirements:

1. Section 078413 “Penetration Firestopping” for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

## PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

## 2.2 STACK-SLEEVE FITTINGS (Not for Use as a Floor Drain)

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. No preference

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. No preference

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel or Plastic or Stainless steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

## 2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. No preference

B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION**

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2-inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 7. When Division 7 sealant section is not provided, provide waterproof sealant system recommended by sleeve manufacturer.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 7. When not specified in Division 7 provide a complete UL fire closure system.

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 7. When not specified in Division 7, provide flashing per manufacturer's recommendation.
3. Install section of cast-iron soil pipe to extend sleeve to 2-inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 7. When not specified in Division 7 provide a complete UL fire closure system.

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION (In slabs on grade and below grade in exterior concrete walls, for a watertight seal around service piping entries into the building. Installation in a sleeve required)

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION (Above and below grade in concrete slabs and in concrete walls for a watertight seal around piping. Sleeve not required)

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

## 3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves or Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves or Sleeve-seal fittings.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves or Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system or Sleeve-seal fittings.
      1) For sleeve-seal system, select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system. Not for use with sleeve-seal fittings.

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
      1) For sleeve seal systems, select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system. Not for use with sleeve-seal fittings

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system or [Galvanized-steel-pipe sleeves with sleeve-seal system or Sleeve-seal fittings.
      1) For sleeve seal systems, select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system. Not for use with sleeve-seal fittings

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves.
      1) For sleeve seal systems, select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system. Not for use with sleeve-seal fittings

4. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or Stack-sleeve fittings or Sleeve-seal fittings or Molded-PE or -PP sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.

5. Interior Partitions:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

**END OF SECTION**

**SECTION 23 05 18**

**ESCUTCHEONS FOR HVAC PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

## PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
f. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with rough-brass finish.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
f. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

**END OF SECTION**

**SECTION 23 05 19**

**METERS AND GAGES FOR HVAC PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Divisions 23 and 26 apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.

1.3 SUBMITTALS

A. Product Data: For each type of thermometer, pressure gauge and flow indicator.

## PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Miljoco Corporation.
   b. Trerice, H. O. Co.
   c. Weiss Instruments, Inc.
   d. Winters Instruments - U.S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.2 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

## 2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AMETEK, Inc.; U.S. Gauge.
    b. Ashcroft Inc.

c. Marsh Bellofram.
d. Miljoco Corporation.
e. Trerice, H. O. Co.
f. Weiss Instruments, Inc.
g. Winters Instruments - U.S.

2. Standard: ASME B40.100.
3. Case: cast aluminum; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, 1 percent of full scale range.

## 2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass for carbon steel or copper pipe, stainless steel for stainless steel pipe; with NPS 1/4 or NPS ½ matching gauge pipe size, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of pipe with NPS 1/4 or NPS 1/2 pipe threads. Match gauge pipe size and material.

C. Valves: Brass ball, Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads. Match gauge pipe size and material.

## 2.6 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Miljoco Corporation.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting. 1-1/2” length for non-insulated piping and 3” length for insulated pipe.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 275 deg F.

F. Core Inserts: Self-sealing rubber compatible with fluid type at operating temperature.

2.7 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Miljoco Corporation.
2. National Meter, Inc.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.

B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.8 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Archon Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Brooks Instrument.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.9 FLOWMETERS

A. See Division 23 temperature controls sections for flow meter product requirements. See part 3 for installation requirements.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install valve and snubber in piping for each pressure gage for fluids (except steam).

I. Install valve and syphon fitting in piping for each pressure gage for steam.

J. Install test plugs in piping tees.

K. Install flow indicators in piping systems in accessible positions for easy viewing.

L. Assemble and install connections, tubing, and accessories between flow-measuring elements according to manufacturer's written instructions.

M. Install flowmeter elements in accessible positions in piping systems.

N. Install flowmeters, with at least minimum straight lengths of pipe, upstream and downstream from meter (minimum 10 upstream / 4 downstream) or according to manufacturer's written instructions whichever is stricter.

O. Install isolation valves upstream and downstream of flowmeters. Maintain minimum straight diameters up/downstream of flowmeters between meter and valves.

P. Install flow meters in the horizontal when possible. If meters are installed in the vertical, the direction of flow must be up.

Q. Install permanent indicators on walls or brackets in accessible and readable positions.

R. Install connection fittings in accessible locations for attachment to portable indicators.

S. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

T. Install thermometers in the following locations:

1. Outside-, return-, supply-, and mixed-air ducts.
2. Where indicated on plans and details.

U. Install pressure gages in the following locations:

1. Where indicated on plans and details.

3.2 CONNECTIONS

A. Install gages adjacent to machines and equipment to allow service and maintenance of gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Install Industrial-style, liquid-in-glass type thermometers where indicated on plans and details. If not indicated on drawings, install thermometers at the inlet/outlet of each hydronic zone, inlet/outlet of each boiler, inlet/outlet of each chiller, inlet/outlet of each air handling coil, inlet/outlet of each tank and inlet/outlet of each heat exchanger. Thermometer stems shall be of length to match thermowell insertion length.

B. Install sealed, industrial-style, liquid in glass type thermometers at outside-, return-, supply-, and mixed-air ducts.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

B. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

C. Scale Range for Dual Temperature, Water Piping: 30 to 240 deg F.

D. Scale Range for Air Ducts: Minus 40 to plus 160 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages where indicated on plans and details. If not indicated on drawings, install pressure gages at the inlet/outlet of each pressure reducing valve, across inlet/outlet of each boiler/chiller/air handling coil/tank/heat exchanger/pump/pump suction diffuser/pump triple duty valve. Pressure gages shall be the following:

1. Direct-mounted, dial type with metal case.
2. Test plug with self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi

B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

C. Scale Range for Dual Temperature-Water Piping: 0 to 100 psi.

**END OF SECTION**

**SECTION 23 05 23**

**GENERAL DUTY VALVES FOR HVAC PIPING.**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 23 and 26 apply to this section.

1.2 SUMMARY

A. This Section includes the following general-duty valves:

1. Copper-alloy ball valves.
2. Ferrous-alloy butterfly valves.
3. Bronze check valves.
4. Ferrous-alloy wafer check valves.
5. Chainwheel actuators.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. SWP: Steam working pressure.
6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS: submit valves along with hydronic pipe indicated in spec 232113. Submit separately gas valves per spec 231123. Submit separately refrigeration vavles and components per spec 232300.

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.7 WARRANTY

A. Written manufacturer's warranty covering parts and labor for a period of one year from substantial completion, or eighteen months from shipment, whichever is longer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide valves by one of the following:

B. Ball valves:

1. Conbraco Industries, Inc.; Apollo Div.
2. Crane Co.; Crane Valve Group; Stockham Div.
3. NIBCO INC.
4. Watts Industries, Inc.; Water Products Div.

C. Ferrous-alloy butterfly valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.
3. NIBCO INC.
4. Watts Industries, Inc.; Water Products Div.
5. Victaulic

D. Bronze check valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.
3. NIBCO INC.
4. Watts Industries, Inc.; Water Products Div.

E. Ferrous-alloy wafer check valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. NIBCO INC.
3. Watts Industries, Inc.; Water Products Div.

F. Chainwheel actuators:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries, Inc.

2.2 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive: For quarter-turn valves NPS 8 and larger.
3. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller.

G. Valves in insulated piping shall have 2-inch stem extensions and the following features:

1. Ball valves shall have extended operating handle of no-thermal conductive material, protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation, and memory stops that are fully adjustable after insulation is applied.

2. Butterfly valves shall have extended necks.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.

I. Valve Grooved Ends: AWWA C606.

1. Solder Joint: With sockets according to ASME B16.18.

a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

2. Threads shall be in accordance with ASME B1.20.1.

J. Valve bypass and drain connections shall follow MSS SP-45.

## 2.3 BRONZE BALL VALVES

A. Ball Valves, 4 Inches and Smaller: MSS SP-110, Class 150, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for 1/2-inch valves and smaller and conventional port for 3/4-inch valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:

1. Operator: Steel handwheel.
2. Stem Extension: For valves installed in insulated piping.
3. Memory Stop: For operator handles.
4. Drain Valve Application: Hose connection with cap and chain.

## 2.4 FERROUS-ALLOY BUTTERFLY VALVES

A. General: MSS SP-67, Type I, for tight shutoff, with disc and lining suitable for potable water, unless otherwise indicated. 200-psi CWP, 150-psi maximum pressure differential, ASTM A 126 cast-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals, wafer, lug, or grooved style:

1. Disc Type: Nickel-plated ductile iron, Aluminum bronze, elastomer-coated ductile iron or epoxy-coated ductile iron.
2. Operator for Sizes 2 Inches to 6 Inches: Standard lever handle with memory stop.
3. Operator for Sizes 8 Inches to 24 Inches: Gear operator with position indicator.
4. Operator for Sizes 8 Inches and Larger, 96 Inches or Higher above Floor: Chain-wheel operator.

## 2.5 BRONZE CHECK VALVES

A. Swing Check Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body

and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections:

B. Swing Check Valves, 3 Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

2.6 WAFER CHECK VALVES

A. Class 125, 200-psi CWP, ASTM A 126 cast-iron body, bronze disc/plates, stainless-steel pins and springs, Buna N seals, installed between flanges.

2.7 CHAINWHEEL ACTUATORS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
3. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

## 3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly valves.
2. Throttling Service: Ball, butterfly, or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves.
4. Drain Valves: Ball valves with hose connection adaptor, cap and chain.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Chilled-Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: 600-psig CWP rating, copper alloy.
2. Butterfly Valves, NPS 2-1/2 and Larger: Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
4. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
5. Wafer Check Valves, NPS 2-1/2 and Larger: Single-plate, wafer, Class 125 or 150 ferrous alloy.

D. Dual Temperature-Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: 600-psig CWP rating, copper alloy.
2. Butterfly Valves, NPS 2-1/2 and Larger: Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.
3. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
4. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
5. Wafer Check Valves, NPS 2-1/2 and Larger: Single-plate, wafer, Class 125 or 150 ferrous alloy.

E. Make-up Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.
4. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.

F. Heating Water Piping: Use the following types of valves:

1. Ball Valves, NPS 2 and Smaller: Two-piece, 600-psig CWP rating, copper alloy.
2. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
3. Butterfly Valves, NPS 2-1/2 and Larger: Flanged, 150-psig CWP rating, ferrous alloy, with EPDM liner.
4. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 125, bronze.
5. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 125, gray iron.
6. Wafer Check Valves, NPS 2-1/2 and Larger: Single-plate, double-flanged Class 125, ferrous alloy.

G. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for heating hot water, steam, and steam condensate services.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

## 3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

## 3.4 JOINT CONSTRUCTION

A. Refer to other Division 23 Sections for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

## 3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

**END OF SECTION**

**SECTION 23 05 29**

**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 22, 23 and 26 apply to this section.

### 1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 055000 “Metal Fabrications” for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230548 “Vibration Controls for HVAC” for vibration isolation devices.
3. Section230516 “Expansion Fittings and Loops for HVAC Piping” for pipe guides and anchors.
4. Section 233113 “Metal Ducts” Section for duct hangers and supports.

### 1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

### 1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers, pipe stands and equipment supports. Design shall include a comprehensive engineering analysis by a qualified professional engineer.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. None.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

**PART 2 - PRODUCTS**

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports (Indoor Non-Corrosive Environment):

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of pre-galvanized or hot dipped carbon steel.

B. Stainless-Steel Pipe Hangers and Supports (Outdoor or Indoor Corrosive Environments and Natatoriums):

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger and Rods: Continuous-thread rod, nuts, and washer made of 316 stainless steel.

C. Copper Pipe Hangers (Indoor Non-Corrosive Environments):

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

## 2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural galvanized carbon-steel shapes with MSS SP-58 galvanized carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. Flex-Strut Inc.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut Corporation; Tyco International, Ltd.
    g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted galvanized steel channel with inturned lips.
5. Channel Nuts: Formed or stamped galvanized steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel with hot dipped galvanized coating (indoor, non-corrosive environments), 316 stainless steel (outdoor or corrosive and natatorium environments).

## 2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2-inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-galvanized steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless (corrosive environments) steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-galvanized steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## 2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural galvanized carbon-steel shapes.

## 2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field-fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4-inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 7 for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-galvanized steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-galvanized steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

## 3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.
5. Provide galvanized paint at all weld locations to match adjacent metal.

## 3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

## 3.5 PAINTING

A. Touchup (Utilize when Division 9 painting sections do not exist on project): Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup (Utilize when Division 9 painting sections exist on project): Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## 3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use galvanized carbon-steel pipe hangers and supports, metal trapeze pipe hangers and galvanized metal framing systems and attachments for indoor general service applications, indoor non-corrosive environments and natatoriums.

F. Use stainless-steel pipe hangers for outdoor applications, indoor corrosive environments, natatoriums and shower/locker areas.

G. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

H. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

I. Use padded hangers for piping that is subject to scratching.

J. Use thermal-hanger shield inserts for insulated piping and tubing.

K. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Galvanized Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Galvanized Carbon- or Galvanized Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Galvanized Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

7. Adjustable, Galvanized Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with galvanized steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with galvanized steel-pipe base stanchion support and cast-iron floor flange or galvanized carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with galvanized steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

L. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Galvanized Carbon- or Galvanized Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

M. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Galvanized Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Galvanized Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Galvanized Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

N. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Galvanized Steel Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Galvanized Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Galvanized Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Welded-Galvanized Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

12. Side-Beam Brackets (MSS Type 34): For sides of galvanized steel or wooden beams.
13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

O. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Galvanized Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

P. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54) - Mounted horizontally.
    b. Vertical (MSS Type 55) - Mounted vertically.
    c. Trapeze (MSS Type 56) - Two vertical-type supports and one trapeze member.

Q. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

R. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

S. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

**END OF SECTION**

**SECTION 23 05 48**

**VIBRATION CONTROLS FOR HVAC**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes the following:

1. Vibration isolation for piping, duct and equipment.
2. Equipment isolation bases.
3. Flexible piping connections.
4. Resilient pipe anchors and guides.

### 1.2 SUBMITTALS

A. Catalog cut sheets that include rated load, rated deflection, and overload capacity for each vibration isolation device.

B. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports.

C. Submit details of equipment bases including dimensions, structural member sizes and support point locations.

D. Submit details of isolation hangers for ceiling hung equipment, piping and ductwork.

E. Submit details of mountings for floor-supported equipment, piping and ductwork.

F. All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements in the specifications.

G. Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.

H. Provide complete flexible connector details.

### 1.3 QUALITY ASSURANCE

A. The isolation materials manufacturer shall be responsible for the proper selection of spring rates to accomplish the specified minimum static deflections for all spring and pay type isolators based on the weight distribution of equipment to be isolated.

B. The isolation materials manufacturer shall be responsible for the structural design of steel beam bases and concrete inertia bases to support mechanical equipment scheduled or specified to receive a supplementary base.

C. Furnish a complete set of final Shop Drawings of all mechanical equipment to receive vibration isolation devices to the vibration isolation materials manufacturer. These Drawings will be the basis upon which the selection of vibration isolators and design of supplementary bases will be completed. The Shop Drawings to be furnished shall include operating weight of the equipment to be isolated and the distribution of weight to the support points.

D. Furnish a complete layout of piping and ductwork to be isolated, including vertical risers, showing size or weight and support points of the piping system to the vibration isolation materials manufacturer for selection and layout of isolation hangers.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store equipment in accordance with manufacturer's instructions.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide vibration controls by one of the following:

1. Mason Industries.
2. Vibration Eliminator Company.
3. Kinetics Noise Control, Inc.
4. Vibration Mountings and Controls, Inc.

2.2 VIBRATION ISOLATOR SELECTION

A. Noise and vibration isolator types, minimum operating static deflections, and supplemental bases shall be provided for individual mechanical equipment units according to selection criteria delineated in Table 1 incorporated as part of this specification or as tabulated in the equipment schedules of the project Drawings.

B. Isolator types are scheduled to establish minimum standards. At the Contractor's option labor saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages, provided isolators supplied incorporate and specified isolator type, and do not degrade the noise and vibration isolation of equipment mounted.

C. Supplemental equipment base types tabulated can be deleted for unitary packaged air handling equipment having a rigid frame and casing providing a distortion free platform for attachment of vibration isolators.

D. Isolators exposed to the outdoors shall have weather-proof finish on all parts.

## 2.3 NEOPRENE MOUNTINGS

A. Neoprene mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang. Mountings shall be type ND or rails type DNR as manufactured by Mason Industries, Inc.

## 2.4 SPRING ISOLATORS

A. General: Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be type SLF, as manufactured by Mason Industries, Inc.

B. Equipment with Significant Weight Variations: Equipment with significant variations in the operating and installed weight, and equipment exposed to the wind shall be mounted on spring mountings as described above. Provide a neoprene acoustical pad within a rigid-sided housing with vertical limit stops to prevent spring extension when weight is removed. Also provide temporary steel spacers between the upper and lower housings. Housings shall serve as blocking during erection. When the equipment is at full operating weight, the springs shall be adjusted to assume the weight and the spacers removed, without changing the installed and operating heights. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 0.75" larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 0.5" to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation. When there is no provision for direct mounting, cooling tower mounts are to be located between the supporting steel and the roof, or the grillage and dunnage as shown on the drawings. Housings and springs shall be powder coated and hardware electro-galvanized. Mountings shall be SLR as manufactured by Mason Industries, Inc.

C. Spring Locks: Hangers shall be precompressed and locked at the rated deflection by means of a resilient upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.

## 2.5 HORIZONTAL THRUST RESTRAINTS

2.6 STEEL BASES

distortion of equipment. Inverted saddles shall be type ICS, as manufactured by Mason Industries, Inc.

A. Floating Bases: Manufacturer shall furnish rectangular steel concrete pouring forms for floating concrete bases. Bases for split case pumps shall be of sufficient size to provide support for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom. Furnish forms with steel templates to hold the anchor bolt sleeves and anchor bolts while pouring concrete. Employ height-saving brackets in all mounting locations to maintain a 1" clearance below the base. Wooden formed bases are not acceptable. Base shall be type BMK or K as manufactured by Mason Industries, Inc.

## 2.7 CURB-MOUNTED VIBRATION ISOLATION BASES

A. Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal. Aluminum members shall house electro-galvanized or powder-coated springs selected for 0.75" minimum deflection. Travel to solid shall be 1.5" minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds. Use manufacturer's self-adhering closed-cell sponge gaskets above and below the base, with a flexible EPDM duct-like connection to seal the outside perimeter. Foam or other sliding or shear seals are not acceptable. Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. Curb mounted bases shall be Type CMAB as manufactured by Mason Industries, Inc.

## 2.8 VIBRATION ISOLATION CURBS

A. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 1/4" thick. Steel springs shall be laterally stable and rest on 1/4" thick neoprene acoustical pads. Hardware shall be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for R-10 of insulation. Curb shall be type RSC as manufactured by Mason Industries, Inc. See 237416.13 for pressure drop, spring deflection (2”) and leakage requirements.

## 2.9 EXPANSION JOINTS

A. Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 1-1/2" through 14" shall have a ductile iron external ring between the two spheres. Sizes 16" through 24" may be single sphere. Sizes 3/4" through 2" may have one sphere, bolted threaded flange assemblies and cable retention.

B. Minimum ratings through 14" shall be 250psi at 170°F and 215psi at 250°F., 16" through 24" 180psi at 170°F and 150psi at 250°F. Higher published rated connectors may be used where required.

C. Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.

D. The piping gap shall be equal to the length of the expansion joint under pressure. Control rods passing through 1/2" thick Neoprene washer bushings large enough to take the thrust at 1000 psi of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.

## 2.10 FLEXIBLE STAINLESS STEEL HOSE

A. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes may have male nipples. Minimum lengths shall be as tabulated:

Flanged

| | | |
|---|---|---|
| 3" x 14" (75 x 350mm) | 6" x 20" (150 x 500mm) | 12" x 28" (300 x 700mm) |
| 4" x 15" (100 x 375mm) | 8" x 22" (200 x 550mm) | 14" x 30" (350 x 750mm) |
| 5" x 19" (125 x 475mm) | 10" x 26" (250 x 650mm) | 16" x 32" (400 x 800mm) |

Male Nipples

| | | |
|---|---|---|
| 1/2" x 9" (12 x 225mm) | 1-1/4" x 12" (32 x 300mm) | 2" x 14" (50 x 350mm) |
| 3/4" x 10" (19 x 250mm) | 1-1/2"x 13" (38 x 325mm) | 2-1/2" x 18" (64 x 450mm) |
| 1" x 11" (25 x 275mm) | | |

B. At equipment, hoses shall be installed on the equipment side of the shut off valves horizontal and parallel to the equipment shafts wherever possible. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

## 2.11 SPLIT SEALS

A. Split Seals consist of pipe halves with minimum 3/4" thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240°F, 10 lb. density fiberglass may be used in lieu of the sponge. Seals shall be Type SWS as manufactured by Mason Industries, Inc.

## 2.12 ACOUSTICAL PIPE ANCHORS

A. All directional acoustical pipe anchors, consist of two sizes of steel tubing separated by a minimum 1/2" thickness of 60 duro or softer neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All directional anchors shall be type ADA as manufactured by Mason Industries, Inc.

## 2.13 PIPE GUIDES

A. General: Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of 60 durometer or softer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of 1-5/8" motion, or to meet location requirements. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.

## 2.14 HORIZONTAL PIPE ISOLATION

A. The first four pipe hangers in the main lines near the mechanical equipment shall be as described Paragraph 2.5B. Hangers supporting piping 2" and larger in all other locations throughout the building shall be isolated by hangers as described in Paragraph 2.5A. Floor supported piping shall rest on isolators as described in Paragraph 2.5B. Heat exchangers and expansion tanks are considered part of the piping run. The first four isolators from the isolated equipment shall have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first four hangers shall have 0.75" deflection for pipe sizes up to and including 3", 1-1/2" deflection for pipe sizes over 3" and up to and including 6", and 2-1/2" deflection thereafter. Where piping connects to mechanical equipment install expansion joints as shown in Paragraph 2.10 or stainless hoses as shown in Paragraph 2.11. All piping passing through the equipment walls, floors or ceilings shall be protected against sound leakage by means of an acoustical seal, as described in Paragraph 2.12.

2.15 VERTICAL PIPE ISOLATION

A. Support vertical risers by spring isolators, designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter. Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing. The initial spring deflection shall be a minimum of 0.75", or four times the thermal movement at the isolator location, whichever is greater. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions. Submittal must be stamped and signed by a licensed professional engineer in the employ of the vibration vendor for at least 5 years. Proper provision shall be made for seismic protection in seismic zones. The isolator manufacturer shall be the same firm supplying the mechanical contract. Support spring mountings, anchors, and telescoping guides shall be in accordance with previous paragraphs of this section.

2.16 DUCT ISOLATION

A. All air ducts with a cross section of 2 square feet or larger shall be isolated from the building structure by hangers as shown in Paragraph 2.5C or floor supports with a minimum deflection of 0.75". Isolators shall continue for 50' from the equipment. If air velocity exceeds 1000 fpm, hangers or supports shall continue for an additional 50' or as shown on the drawings.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL

A. All vibration isolators must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

B. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building. This includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.

G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.

H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractors expense.

I. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed specified capabilities.

J. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide seals as described in this specification.

K. Locate isolation hangers as near to the overhead support structure as possible.

L. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight. Horizontal thrust restraints shall be in accordance with this specification.

M. Rooftop equipment isolators must be bolted to the equipment and structure. Mountings must be designed to resist 100 mph wind loads.

## 3.3 VIBRATION ISOLATION OF PIPING

A. Horizontal pipe shall be installed in accordance with 2.15 Horizontal Pipe Isolation.

B. Risers shall be installed in accordance with 2.16 Riser Isolation.

3.4 VIBRATION ISOLATION OF DUCTWORK

A. All duct runs shall be installed in accordance with 2.17 Duct Isolation.

3.5 ISOLATOR SCHEDULE

| | Basement Slab or Slab on Grade | | Upper Floors | |
|---|---|---|---|---|
| Equipment | Paragraph | Min Static Deflect | Paragraph | Min Static Deflect |
| | | | | |
| Screw/Scroll Chiller Comp. | 2.3, 2.10, 2.11 | 0.75 | 2.4B, 2.10, 2.11 | 2 |
| Boilers | Concrete Base | - | 2.4B | 0.75 |
| Pumps Close Coupled Thru 5HP | 2.3, 2.7C | 0.35 | 2.4A, 2.7C | 0.75 |
| 7-1/2HP & Over | 2.4A, 2.7C | 0.75 | 2.4A, 2.7C | 1.5 |
| Pumps Base Mounted | | | | |
| Thru 60HP | 2.4A, 2.7C | 0.75 | 2.4A, 2.7C | 1.5 |
| 75HP & Over | 2.4A, 2.7C | 0.75 | 2.4A, 2.7C | 2.5 |
| Packaged Air Handling Units | | | | |
| Rooftop Units / Outdoor Make Up Air Units | - | - | 2.9 | 1.0 |
| Blowers | | | | |
| Utility Sets | | | | |
| Floor Mounted | 2.3 | 0.35 | 2.4A | 1.5 |
| Roof Mounted | - | - | 2.4A, 2.7 | 1.5 |
| Suspended | - | - | 2.5A | 1.5 |
| Centrifugal Blowers | | | | |
| 15HP & Less | 2.4A, 2.7 | 1.0 | 2.4A, 2.7 | 1.0 |
| 20HP to 60 HP | 2.4A, 2.7C | 1.0 | 2.4A, 2.7C | 2.0 |
| 60HP & Above | 2.4A, 2.7C | 1.0 | 2.4A, 2.7C | 3.0 |
| Fan Casing | | | | |
| Floor Mtd Arrg. #1 or Any Separate | | | | |
| Motor | 2.3, 2.7C, 2.6 | 0.35 | 2.4A, 2.7C, 2.6 | 1.0 |
| Condensing Units | | | 2.4B | 2.0 |
| Power Roof Exhausters Roof Mounted | | | 2.8 | 1.0 |

**END OF SECTION**

**SECTION 23 05 53**

**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. Warning tags.
7. Laminated Flow Diagrams.

1.3 SUBMITTALS: submit one package including items A, B, and C below.

A. Product Data: Equipment labels.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules (provide with close-out documents): For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4- inch.
6. Minimum Letter Size: 1/4- inch for name of units if viewing distance is less than 24-inches, 1/2- inch for viewing distances up to 72-inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation with room number served or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### 2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4- inch.

F. Minimum Letter Size: 1/4- inch for name of units if viewing distance is less than 24-inches, 1/2- inch for viewing distances up to 72-inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.
3. Color: Background color shall match system color. See part 3 for colors.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black, Blue, Red, White, Yellow. See Part 3.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4- inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24-inches, 1/2 inch for viewing distances up to 72-inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch, Stainless steel, 0.025-inch, Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 x 7 inches.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations (both sides) through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25-feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.

B. Pipe Label Color Schedule:

1. Heating Hot Water Piping:

a. Background Color: Orange.
b. Letter Color: White.

2. Refrigerant Piping:

a. Background Color: Black.
b. Letter Color: White.

3. Natural Gas Piping:

a. Background Color: Yellow.
b. Letter Color: Black

4. Non-Potable / Make-Up Water Piping:

a. Background Color: Light Blue.
b. Letter Color: White

5. Air Conditioning / Humidification Condensate Piping:

a. Background Color: Gray.
b. Letter Color: White.

## 3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Red: For hot-air supply ducts.
3. Orange: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. Yellow: For hazardous material exhaust.

B. Locate labels near points where ducts enter and exit concealed spaces and at maximum intervals of 25-feet in each space where ducts are exposed or concealed by removable ceiling system. Reduce distance to 15 feet in highly congested spaces.

## 3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering and hose connections. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
   a. Refrigerant: 2-inches, round.
   b. Heating Hot Water: 2-inches, round.
   c. Natural Gas: 2-inches, round.
   d. Non-Potable / Make-Up Water: 2-inches, round.
   e. Air Conditioning / Humidification Condensate: 2-inches.

2. Valve-Tag Color:
   a. Refrigerant: Natural.
   b. Heating Hot Water: Orange.
   c. Natural Gas: Yellow.
   d. Non-Potable / Make-Up Water: Yellow.
   e. Air Conditioning / Humidification Condensate: Gray.

3. Letter Color:
   a. Refrigerant: White.
   b. Heating Hot Water: White.
   c. Natural Gas: White.
   d. Non-Potable / Make-Up Water: White.
   e. Air Conditioning / Humidification Condensate: White.

## 3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

**END OF SECTION**

**SECTION 23 05 93**

**TESTING, ADJUSTING, AND BALANCING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 22, 23 and 26 apply to this section.

### 1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:

    a. Constant-volume air systems.
    b. Variable-air-volume systems.

2. Hydronic Piping Systems:

    a. Constant-flow systems.
    b. Variable-flow systems.

3. HVAC equipment quantitative-performance settings.
4. Space pressurization.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of activities and procedures specified in this Section.

### 1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

## 1.4 SUBMITTALS

A. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

B. TAB Contractor: The duties of the TAB contractor, during construction and acceptance phases to support commissioning are:

1. A running log of events and issues shall be kept by the TAB field technicians. Submit handwritten reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and CM at least twice a week.

2. Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
3. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.
4. Provide the CxA with any requested data, gathered, but not shown on the draft reports.
5. Provide a final TAB report for the CxA with details, as in the draft.

C. Submit two copies of special warranty specified in the “Warranty” Article of this Section.

D. Submit a complete draft of Final TAB report per section 3.22 as a searchable PDF. Organize and label draft and final report as indicated in section 3.22.

## 1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

    a. Submittal distribution requirements.
    b. The Contract Documents examination report.
    c. TAB plan.
    d. Work schedule and Project-site access requirements.
    e. Coordination and cooperation of trades and subcontractors.
    f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.”

E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 DELIVERY, STORAGE AND HANDLING – NOT APPLICABLE

1.7 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.9 WARRANTY

A. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

**PART 2 - PRODUCTS - NOT APPLICABLE**

**PART 3 - EXECUTION**

3.1 MECHANICAL DEMOLITION – NOT APPLICABLE

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and

that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine strainers for clean screens and proper perforations.

M. Examine two-way and three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine system pumps to ensure absence of entrained air in the suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

R. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

## 3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

## 3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

## 3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

## 3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer. Provide new/replace fan sheaves as required to obtain design cfm.

1. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

## 3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Provide new/replace fan sheaves as required to obtain design cfm.

B. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

C. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written

instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

## 3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

## 3.9 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

## 3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

## 3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

C. Electrically Commutated Motors: Test for proper operation at speeds varying from minimum to maximum. Record observations, including controller manufacturer, model and serial numbers, and nameplate data. Fan coils: Field adjust the 3 speed setpoints to achieve final approved airflow settings.

## 3.12 PROCEDURES FOR BOILERS/WATER HEATERS

A. Hydronic, measure entering- and leaving-water temperatures, combustion air pressure at air inlet, flue outlet gas pressure at boiler/water heater, natural gas pressure upstream of gas train and at equipment inlet,water flow and associated pressure drop.

## 3.13 ADDITIONAL PROCEDURES FOR DUCTLESS FAN COILS

A. Measure the following data for each unit:

1. Airflow at three airflow setpoints.
2. Water flow rate.
3. Water pressure drop.

## 3.14 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Refrigerant Coils: Measure the following data for each coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

## 3.15 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.

B. Measure, adjust, and record the pressurization of each room, each zone, and each floor by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.

C. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.

1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
3. Test room pressurization first, then zones, and finish with building pressurization.

D. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.

E. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.

1. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
2. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.
3. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.

F. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.

G. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

## 3.16 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

## 3.17 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

## 3.18 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: 0 to plus 10 percent.
2. Air Outlets and Inlets: Plus 10 to minus 10 percent.
3. Heating-Water Flow Rate: Plus 5 to minus 10 percent.
4. Cooling / Dual temperature-Water Flow Rate: Plus 5 to minus 5 percent.

## 3.19 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

## 3.20 FINAL REPORT

A. General: Word processor printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.

b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:

a. Settings for outside-, return-, and exhaust-air dampers.
b. Conditions of filters.
c. Cooling coil, wet- and dry-bulb conditions.
d. Face and bypass damper settings at coils.
e. Fan drive settings including settings and percentage of maximum pitch diameter.
f. Inlet vane settings for variable-air-volume systems.
g. Settings for supply-air, static-pressure controller.
h. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Air-Handling / Roof Top Unit / Make Up Air Unit Test Reports: For equipment with coils, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
j. Number of belts, make, and size.
k. Number of filters, type, and size.

2. Motor Data:

a. Make and frame type and size.
b. Horsepower and rpm.

c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg. Separate values for pre/final for each bank.
f. Preheat coil / furnace static-pressure differential in inches wg.
g. Cooling coil static-pressure differential in inches wg.
h. Heating coil / furnace static-pressure differential in inches wg.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Exhaust airflow in cfm.
l. Outside-air damper position.
m. Return-air damper position.
n. Exhaust/relief-air damper position.
o. Vortex damper position.

G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btuh.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.

f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btuh.
i. High-fire fuel input in Btuh.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btuh.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in fan coil units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btuh.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft.
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btuh.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.
    b. Average face velocity in fpm.
    c. Air pressure drop in inches wg.
    d. Outside-air, wet- and dry-bulb temperatures in deg F.
    e. Return-air, wet- and dry-bulb temperatures in deg F.
    f. Entering-air, wet- and dry-bulb temperatures in deg F.
    g. Leaving-air, wet- and dry-bulb temperatures in deg F.
    h. Water flow rate in gpm.
    i. Water pressure differential in feet of head or psig.
    j. Entering-water temperature in deg F.
    k. Leaving-water temperature in deg F.
    l. Refrigerant expansion valve and refrigerant types.
    m. Refrigerant suction pressure in psig.
    n. Refrigerant suction temperature in deg F.
    o. Inlet steam pressure in psig.

J. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches, and bore.
    h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

    a. Make and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

K. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft.
    g. Indicated airflow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual airflow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

L. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Test apparatus used.
    d. Area served.
    e. Air-terminal-device manufacturer.
    f. Air-terminal-device number from system diagram.
    g. Air-terminal-device type and model number.
    h. Air-terminal-device size.
    i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm
    b. Air velocity in fpm.
    c. Preliminary airflow rate as needed in cfm.
    d. Preliminary velocity as needed in fpm.
    e. Final airflow rate in cfm.
    f. Final velocity in fpm.
    g. Space temperature in deg F.

3. Evaporator Test Reports (Indicated and Actual Values):

    a. Refrigerant pressure in psig.
    b. Refrigerant temperature in deg F.
    c. Entering-water temperature in deg F.
    d. Leaving-water temperature in deg F.
    e. Entering-water pressure in feet of head or psig.
    f. Water pressure differential in feet of head or psig.

4. Compressor Test Data (Indicated and Actual Values):

    a. Suction pressure in psig.
    b. Suction temperature in deg F.
    c. Discharge pressure in psig.

d. Discharge temperature in deg F.
e. Oil pressure in psig.
f. Oil temperature in deg F.
g. Voltage at each connection.
h. Amperage for each phase.
i. Kilowatt input.
j. Crankcase heater kilowatt.
k. Chilled-water control set point in deg F.
l. Refrigerant low-pressure-cutoff set point in psig.
m. Refrigerant high-pressure-cutoff set point in psig.

5. Refrigerant Test Data (Indicated and Actual Values):

a. Oil level.
b. Refrigerant level.
c. Relief valve setting in psig.
d. Unloader set points in psig.
e. Percentage of cylinders unloaded.
f. Bearing temperatures in deg F.
g. Vane position.
h. Low-temperature-cutoff set point in deg F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.

f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

N. Boiler/Water Heater Test Reports: Include test report for existing boilers.

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.
f. Fuel type and input in Btuh.
g. Number of passes.
h. Ignition type.
i. Burner-control types.
j. Voltage at each connection.
k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):

a. Operating pressure in psig.
b. Operating temperature in deg F.
c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.
e. Number of safety valves and sizes in NPS.
f. Safety valve settings in psig.
g. High-limit setting in psig.
h. Operating-control setting.
i. High-fire set point.
j. Low-fire set point.
k. Voltage at each connection.
l. Amperage for each phase.
m. Draft fan voltage at each connection.
n. Draft fan amperage for each phase.
o. Manifold pressure in psig.

O. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.21 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

3.22 CLEANING –NOT APPLICABLE

3.23 CONTRACTOR STARTUP AND REPORTING – NOT APPLICABLE

3.24 DEMONSTRATION AND COMMISSIONING

A. The contractor will demonstrate up to 10% of measurements to confirm if more that 10% of those readings vary by more than 10% from the reported reading the report will be corrected. With the corrected report the contractor will demonstrate a 10% sample of points chosen by the commissioning agent. This process will continue until the criteria are satisfied.

**END OF SECTION**

**SECTION 23 07 15**

**HVAC INSULATION**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of Division 22, 23 and 26 apply to this section.

1.2 SUMMARY

A. Section includes:

1. Insulation Materials:
   a. Flexible elastomeric.
   b. Mineral fiber.
   c. Polyisocyanurate.
   d. Fire Rated Blanket.
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Lagging adhesives.
7. Sealants.
8. Factory-applied jackets.
9. Field-applied jackets.
10. Tapes.
11. Securements.
12. Corner angles.

1.3 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.

B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75 deg F.

D. Thermal Resistivity: "R-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogeneous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between

two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.

E. Density: Is expressed in lb/cu.ft.

## 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
8. Detail field application for each equipment type (i.e. return fans on roof, AHU plenum/deck dividers).

C. Submit certification stating that all adhesives & sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers, including 2004 Addenda.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Containers for insulation material, coverings, cements, adhesives and coatings shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

B. Protect against dirt, water and chemical and mechanical damage. Do not install damaged or wet insulation. Remove any such damaged and wet insulation from site.

## 1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application; duct Installer for duct insulation application, and equipment Installer for equipment insulation application Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

## 1.9 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## 1.10 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of, whichever is longer.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Flexible Elastomeric:

   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

2. Mineral-Fiber Blanket Insulation:

   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Owens Corning; All-Service Duct Wrap.

3. Mineral-Fiber Board Insulation:

   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

4. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating. Products:

   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap Products.
   f. Unifrax Corporation; FyreWrap.
   g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

5. Mineral-Fiber, Preformed Pipe Insulation:

   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000 Pipe Insulation.
   d. Owens Corning; Fiberglas Pipe Insulation.

6. Mineral-Fiber, Pipe and Tank Insulation:

   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.

c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

7. Polyisocyanurate:

a. Apache Products Company; ISO-25.
b. Dow Chemical Company (The); Trymer.
c. Duna USA Inc.; Corafoam.
d. Elliott Company; Elfoam.

8. Mineral-Fiber Insulating Cement:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

9. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement:

a. Insulco, Division of MFS, Inc.; SmoothKote.
b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
c. Rock Wool Manufacturing Company; Delta One Shot.

10. Polyisocyanurate, Adhesive:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.

11. Flexible Elastomeric and Polyolefin Adhesive:

a. Aeroflex USA Inc.; Aeroseal.
b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. RBX Corporation; Rubatex Contact Adhesive.

12. Mineral-Fiber Adhesive:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.

13. ASJ Adhesive, and FSK Adhesive:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.

14. PVC Jacket Adhesive:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. Speedline Corporation; Speedline Vinyl Adhesive.

15. Vapor-Barrier Mastic:

    a. Childers Products, Division of ITW; CP-35.
    b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    c. ITW TACC, Division of Illinois Tool Works; CB-50.
    d. Vimasco Corporation; 749.

16. Lagging Adhesives:

    e. Childers Products, Division of ITW; CP-52.
    f. Foster Products Corporation, H. B. Fuller Company; 81-42.
    g. Vimasco Corporation; 136.

17. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products:

    a. Childers Products, Division of ITW; CP-76.
    b. Foster Products Corporation, H. B. Fuller Company; 30-45.
    c. Pittsburgh Corning Corporation; Pittseal 444.
    d. Vimasco Corporation; 750.

18. Metal Jacket Flashing Sealants:

    a. Childers Products, Division of ITW; CP-76-8.
    b. Foster Products Corporation, H. B. Fuller Company; 95-44.
    c. Vimasco Corporation; 750.

19. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

    a. Childers Products, Division of ITW; CP-76.

20. PVC Jacket:

    a. Johns Manville; Zeston.
    b. P.I.C. Plastics, Inc.; FG Series.
    c. Proto PVC Corporation; LoSmoke.
    d. Speedline Corporation; SmokeSafe.

21. Metal Jacket:

    a. Childers Products, Division of ITW; Metal Jacketing Systems.
    b. PABCO Metals Corporation; Surefit.
    c. RPR Products, Inc.; Insul-Mate.

22. ASJ Tape:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
    b. Compac Corp.; 104 and 105.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

23. FSK Tape:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

24. PVC Tape:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
b. Compac Corp.; 130.
c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.

25. Bands:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

26. Insulation Pins and Hangers:

a. AGM Industries, Inc.; CWP-1.
b. GEMCO; Cupped Head Weld Pin.
c. Midwest Fasteners, Inc.; Cupped Head.
d. Nelson Stud Welding; CHP

27. Wire:

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.

## 2.2 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
2. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.
3. Fabricate shapes according to ASTM C 450 and ASTM C 585.
4. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

a. Pipe Applications: ASJ
b. Equipment Applications: ASJ

## 2.3 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction. In addition, the blanket assembly shall comply with ASTM E 814 and have an “F” and “T” rating equal to the rating of all assemblies penetrated, but not less than 2-hours.

## 2.4 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

## 2.5 ADHESIVES

A. All Adhesives & Sealants: All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers, including 2004 addenda.

B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

C. Cellular-Glass, Phenolic and Polyisocyanurate, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

## 2.6 MASTICS

A. All Mastics All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers, including 2004 Addenda.

B. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.

## 2.7 LAGGING ADHESIVES

A. All Adhesives & Sealants All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers, including 2004 Addenda.

B. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
2. Service Temperature Range: Minus 50 to plus 180 deg F.
3. Color: White.

2.8 SEALANTS

A. All Adhesives & Sealants All adhesive and sealants installed in the building interior shall meet the testing and product requirements of the California Department of Health Services Standard for the Testing of Volatile Organic Emissions from Various Sources Using Small Scale Environmental Chambers, including 2004 Addenda.

B. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

D. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.9 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: Color-code jackets based on system.
   3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   4. Factory-fabricated tank heads and tank side panels.

D. Flexible Weather-Proof Jacket
   1. Manufacturer: Polyguard (Alumaguard Cool Wrap)
   2. Cool Roof Rating Council Initial: solar reflectance = 0.86 / thermal emittance = 0.82
   3. Product thickness: 55-60 mils
   4. Product weight: 0.3 lbs/sf
   5. Water Vapor Transmission / Permeance: ASTME96-00 0 grains/hrxft^2 / 0 US Perms
   6. Peel adhesion: ASTM D1000, >12 lbs/in
   7. Elongation at Break: ASTM D882, 182%
   8. Low Temperature Pliability: ASTM D146, No Cracks @ -15F
   9. Tensile Strength: ASTM D882, 51 lbs/in
   10. Puncture Resistance: ASTM D774, 150 PSI
   11. Mold Resistance: ASTM C1338, Pass
   12. Upper Temperature Limit: 160F
   13. Emissivity: 0.30

E. Metal Jacket:
   1. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      a. Sheet and roll stock ready for shop or field sizing.
      b. Material, finish, and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
      e. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.

8) Field-fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.02 inch3/4 inch wide with wing seal or[closed seal.
2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
    b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.13 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

B. Coordinate insulation installation with the trade installing heat tracing, if any. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

## 3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation,

install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated wall and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire-rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

## 3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

a. Do not weld anchor pins to ASME-labeled pressure vessels.
b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
d. Do not over-compress insulation during installation.
e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. For Hot Water systems, fabricate boxes from galvanized steel, at least 0.050 inch thick.
3. For Dual Temperature, Chilled Water or Cold Water Systems, fabricate boxes from stainless steel at least 0.050 inch thick.
4. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

## 3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles. Coordinate with drawings for insulation at locations of pipe expansion.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated on drawings. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with Manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with Manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6-inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over-compress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over-compress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

## 3.9 POLYISOCYANURATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

## 3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where Stainless Steel jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

## 3.11 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

## 3.12 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ exposed to view only,: Paint jacket with paint system identified below and as specified in Division 9 painting Sections. Coordinate with Architect.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

## 3.13 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each type of equipment requiring insulation for this project. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.14 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, supply and outdoor air.
2. Indoor, return located in unconditioned space.
3. Indoor, kitchen hood exhaust.
4. Indoor, exhaust between isolation damper and penetration of building exterior.
5. Outdoor, supply and return air.
6. Indoor, exhaust air and outside air damper frames.
7. Unused portions of louvers and louver blank-offs

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1 latest edition.
2. Outdoor exhaust ductwork
3. Outdoor air intake ductwork.
4. Factory-insulated flexible ducts.
5. Factory-insulated plenums and casings.
6. Flexible connectors.
7. Vibration-control devices.
8. Factory-insulated access panels and doors.

3.15 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. INSULATION APPLICATION SCHEDULE

1. General: Abbreviations used in the following schedules include:

a. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.

B. DUCT/PLENUM SYSTEMS INSULATION SCHEDULE

| DUCT LOCATION | OUTSDIE AIR, SUPPLY AIR, EXHAUST AIR (DOWN STREAM OF DAMPER) INSULATION INSTALLED R-VALUE (H-FT$^2$-°F)/BTU | RETURN INSULATION INSTALLED R-VALUE (H-FT$^2$-°F)/BTU |
|---|---|---|
| EXTERIOR OF BUILDING (NOTE 5,6,7) | 12.0 | 12.0 |
| DOUBLE WALL DUCTWORK (NOTE 8) | - | - |
| VENTILATED ATTIC (NOTE 5,7) | 12.0 | 12.0 |
| UNVENTED ATTIC ABOVE INSULATED CEILING (NOTE 5,7) | 12.0 | 12.0 |
| UNVENTED ATTIC W/ ROOF INSULATION (NOTE 1,5,7) | 3.5 | - |
| UNCONDITIONED SPACE (NOTE 2,5,6,7) | 6.5 | 6.5 |
| INDIRECTLY CONDITIONED SPACE (NOTE 3,7) | 3.5 | - |
| CEILING CAVITY / SHAFTS / SOFFITS / MECHANICAL SPACES AND ROOMS (NOTE 4,5,6,7) | 3.5 | - |
| FULLY EXPOSED LOCATIONS WITHIN CONDITIONED SPACE | 3.5 | - |
| BURIED | 6.5 | 6.5 |

NOTE 1: INSULATION R-VALUES, MEASURED IN (H X FT^2 X F)/BTU, ARE FOR THE INSULATION AS INSTALLED AND DO NOT INCLUDE FILM RESISTANCE.

NOTE 2: INCLUDING CRAWL SPACES (BOTH VENTILATED/NON-VENTILATED), FRAMED CAVITIES IN WALLS, FLOOR AND CEILING ASSEMBLIES WHICH (A) SEPARATE CONDITIONED SPACE FROM UNCONDITIONED SPACE OR OUTSIDE AIR, AND (B) ARE UNINSULATED ON THE SIDE FACING AWAY FROM CONDITIONED SPACE.

NOTE 3: RETURN AIR PLENUMS WITH OR WITHOUT EXPOSED ROOFS ABOVE.

NOTE 4: CAVITY CONTAINED WITHIN THE INSULATED BUILDING ENVELOPE.

NOTE 5: VAPOR BARRIER REQUIRED.

NOTE 6: FIELD APPLIED JACKET (ALUMAGUARD COOL WRAP BY POLYGUARD FOR EXTERIOR APPLICATIONS, PVC FOR INTERIOR EXPOSED LOCATIONS).

NOTE 7: PROVIDE RIGID EXTRUDED URETHANE (OUTDOOR APPLICATION) OR POLYSTYRENE BOARD (OUTDOOR APPLICATION), OR POLYISOCYANURATE BOARD (OUTDOOR APPLICATIONS), OR CLOSED CELL FLEXIBLE ELASTOMERIC (OUTDOOR APPLICATIONS).

NOTE 8: DO NOT PROVIDE EXTERNAL FIELD APPLIED INSULATION ON DOUBLE WALL DUCTWORK. INTERSTITIAL SPACE INSULATION TO BE PROVIDED WITH PRODUCT. SEE 233113 “METAL DUCTS”.

EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that are not factory insulated.

C. Chilled / dual temperature-water pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density. Vapor barrier. Assembly shall include sheetmetal enclosure with hinges / latches to allow removal / reassembly without damage to insulation.

D. Heating-hot-water pump insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density. Assembly shall include hinges / latches to allow removal / reassembly without damage to insulation.

E. Chilled / dual temperature-water expansion/compression tank insulation shall be:

1. Flexible Elastomeric: 1 inch thick. Vapor barrier and PVC jacket.
2. Mineral-Fiber Pipe and Tank: 1 inch thick. Vapor barrier and PVC jacket.

F. Chilled / dual temperature-water air-separator insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick. Vapor barrier and PVC jacket.
2. Mineral-Fiber Pipe and Tank: 1 inch thick. Vapor barrier and PVC jacket.

G. Piping system filter-housing (side stream filter) insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density. PVC jacket.
2. Mineral-Fiber Pipe and Tank: 2 inches thick. PVC jacket.

H. Louvers: Provide blank-off of all unused portion of louvers. Minimum R12 board insulation with vapor barrier sandwiched between galvanized sheet metal. Caulk/Seal air/weather tight.

3.17 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

| | **FLUID TEMP RANGE (°F)** | **INSULATION TYPE AND FIELD-APPLIED JACKET** | | | **PIPE SIZE AND INSULATION THICKNESS (INCHES)[5][6]** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | GLASS FIBER | POLYISO-CYANURATE | FLEXIBLE ELASTO-MERIC | < 1"[4] | 1" to < 1-1/2" | 1-1/2" to < 4" | 4" to < 8" | 8" & Larger |
| HEATING SYSTEMS[1][7] (Dual Temperature and Hot Water) | | | | | | | | | |
| | | | | | | | | | |
| | 201-250 | X[1][2][9] | | | 2-1/2 | 2-1/2 | 2-1/2 | 3 | 3 |
| | 141-200 | X[1][2][9] | | | X[2][3][9] | 1-1/2 | 2 | 2 | 2 |
| | 105-140 | X[1][2][9] | | | X[2][3][9] | 1 | 1-1/2 | 1-1/2 | 1-1/2 |
| | | | | | | | | | |
| COOLING SYSTEMS[1][7][10] (Chilled water, refrigerant, brine and air conditioning condensate) | 40-60 | X[1][2][8][9] | X[2][3][8][9] | X[8][9][2][3] | 1 | 1 | 1-1/2 | 1-1/2 | 1-1/2 |
| | < 40 | X[1][2][8][9] | X[2][3][8][9] | X[8][9][2][3] | 1 | 1-1/2 | 1-1/2 | 1-1/2 | 1-1/2 |

3.18 PIPING INSULATION SCHEDULE

A. General:

B. Abbreviations used in the following schedules include:

1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.
2. Pipe Sizes: NPS - Nominal Pipe Size.
3. Minimum HVAC pipe insulation thickness table:

NOTES:

1. Glass fiber insulation only for indoor field applied hydronic piping.
2. (A), or (SS) or Alumaguard Cool Wrap by Polyguard (Flexible Weather Proof Jackets). Field-applied Jacket on outdoor installations, exposed and concealed.
3. For outdoor use only.
4. Piping insulation is not required between the control valve and coil on run-outs when the control valve is within 4-feet of the coil and the pipe size is 1" or less on heating only systems.
5. For piping exposed to outdoor air, increase insulation thickness by 1-inch.
6. Insulation thickness is based on the corresponding fluid temperature (F), Conductivity Btu/in(h x ft^2 x F), and mean rating temperature (F) as follows:
   - 251-350 F fluid temp., 0.29 – 0.32 Btu/in(h x ft^2 x F) conductivity, 200 F mean temp.
   - 201-250 F fluid temp., 0.27 – 0.30 Btu/in(h x ft^2 x F) conductivity, 150 F mean temp.
   - 141-200 F fluid temp., 0.25 – 0.29 Btu/in(h x ft^2 x F) conductivity, 100 F mean temp.
   - 40-60 F fluid temp., 0.21 – 0.27 Btu/in(h x ft^2 x F) conductivity, 75 F mean temp.
7. Dual temperature water shall be treated as 141-200 F hot water with a vapor barrier.
8. Vapor barrier.
9. Vapor barrier (Dual temperature / Chilled water / Make-up water applications)
10. Insulate both suction and liquid refrigerant lines and accessories with flexible elastomeric insulation.

3.19 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Exposed:

1. PVC: 20 mils thick.

3.20 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Stainless Steel, Type 304, Smooth 2B Finish: 0.016 inch thick.

C. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Stainless Steel, Type 304,[Smooth: 0.020 inch thick.

D. Piping, Exposed

1. Stainless Steel, Type 304 Smooth 2B Finish 0.016 inch thick.

**END OF SECTION**

**SECTION 23 09 00**

**BUILDING AUTOMATION SYSTEM**

## PART 1 - GENERAL

1.1 WORK INCLUDES

A. All controls related work including but not limited to a complete and fully functional building automation system as shown on the construction documents (all trades) and as inferable to meet the intent of the project. All wiring/completing of all loose shipped controls furnished with equipment / systems shall be provided by the temperature controls provider.

1.2 GENERAL REQUIREMENTS

A. Provide a complete and operational system to perform all sequences of operations stated within the following documents:

B. The work under this Section shall include all materials and equipment, labor and services to perform all work required for the installation of the BAS as herein specified and as otherwise required to provide a complete and operating system according to standard industry practices.

C. Note that the drawings and specifications are complementary to one another, meaning that what is called for on one is to be considered called for in both. Where conflicts exist between the specifications and/or drawings, the more stringent or inclusive requirement shall apply.

D. Code requirements are considered a minimum standard. Where materials shown on the drawings or indicated in the specifications exceed code requirements, the plans and specifications shall govern.

E. Minor BAS items, accessories, devices, or program features reasonably inferable as necessary, to the complete and proper installation and operation of any system, shall be provided by the BAS Contractor for such system whether or not they are specifically called for by these specifications or drawings.

F. If there are any questions concerning the nature, extent or intent of the BAS work to be performed after examining all drawings and documents pertaining to this project, the contractor installing the BAS shall be responsible for obtaining clarification to those questions from the Engineer prior to submitting project bid and/or technical proposal. Once a contract is awarded, claims of ignorance of the project requirements will not be considered.

G. Where work specified under other Sections of these Specifications connects to equipment or systems which are a part of this Section, provide proper connection(s) to such equipment including trade coordination.

H. Provide labor to coordinate with the contractor performing Test and Balance work.

I. Provide startup, programming, testing, and using agency instruction as specified herein.

1.3 SPECIFIC REQUIREMENTS

A. Direct Digital Control: The BAS shall be fully Direct Digital Control (DDC) unless specifically stated to the contrary in the drawings or sequence of operation.

B. Web Base Interface: The BAS will employ a thin client web-based interface. The BAS contractor will coordinate with the using agency's IT (Information Technology) personnel to determine the most appropriate type of web interface.

C. Tridium Interface: The BAS will employ a web interface based on Tridium Niagara 4 for Network Infrastructure (JACE Network Controllers, Tridium Web Server, Workplace Pro). No substitutions will be allowed. All Tridium products shall be full Niagara 4 network solution.

D. Communication Protocol: All controller-to-controller communication, controller-to-workstation communication and controller-to-Internet communication within the BAS will take place over open protocol networks that comply with the following (or one of the following) industry standard(s):

1. BACnet over IP-Top, BACnet MS/TP bottom

E. Commissioning: This Section specifies equipment or systems, which shall be commissioned as part of the construction process. The contractor will be required to provide documentation and testing of these systems and shall work in cooperation with the Commissioning Authority (CxA) to ensure compliance. See Related Documents below for further details.

F. Warranty: The warranty shall conform to this specification as detailed below and shall be for the following duration:

1. Two (2) years from date of substantial completion

G. Test and Balance: This project will be tested and balanced by a Test & Balance Contractor. Provide labor to coordinate with the contractor performing Test and Balance work

H. The BAS shall consist of the following components and equipment:

1. Distributed Microprocessor based remote control panels interfacing directly with sensors, transducers, and relays.
2. A communication network to allow data exchange between DDC controllers, third party devices (connected via protocol interface), dedicated web servers, and operator workstations
3. Laptop computer and desktop operator workstations, as specified, with all monitoring, licensing, programming, control and service software. Electric and electronic controls for all items indicated on drawings and described hereinafter including sensors, transducers, valves, dampers, panels, and electrical installation.

1.4 RELATED DOCUMENTS

A. Divisions 0 and 1: The Contractor is bound by the provisions of Division 0 and Division 1. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of this specification and shall be used in conjunction with this section as a part of the contract documents. Consult them for further instructions pertaining to this work.

B. Division 23 and 26: All sections of Divisions 0, 23000 and 26000 constitute related work.

C. Commissioning Specifications: The following specification sections related to the commissioning process constitute related work:

1. Section 019113 – Commissioning
2. Section 220800 – Plumbing Commissioning
3. Section 230800 – Mechanical Commissioning
4. Section 260800 – Electrical Commissioning

1.5 DEFINITIONS & ABBREVIATIONS:

A. Abbreviations:

| | | |
|---|---|---|
| 1. | AI | Analog Input |
| 2. | AO | Analog Output |
| 3. | ASC | Application-Specific Controller |
| 4. | BI | Binary Input |
| 5. | BO | Binary Output |
| 6. | CHW | Chilled Water |
| 7. | CA or CxA | Commissioning Authority |
| 8. | CW | Condenser Water |
| 9. | DAT | Discharge-Air Temperature |
| 10. | DDC | Direct Digital Control |
| 11. | DHW | Domestic Hot Water |
| 12. | DP | Differential Pressure |
| 13. | DPS | Differential Pressure Switch |
| 14. | DPT | Differential Pressure Transmitter |
| 15. | ELC | Enterprise-Level Controller |
| 16. | BAS | Building Management System |
| 17. | HW | Hot Water |
| 18. | IT | Information Technology |
| 19. | LEED | Leadership in Energy and Environmental Design |
| 20. | MAT | Mixed-Air Temperature |
| 21. | N/A | Not Applicable |
| 22. | OAH | Outside-Air Relative Humidity |
| 23. | OAT | Outside-Air Temperature |
| 24. | PC | Personal Computer |
| 25. | POT | Portable Operator Terminal |
| 26. | RAH | Return-Air Humidity |
| 27. | RAT | Return-Air Temperature |
| 28. | SLC | System-Level Controller |
| 29. | TC | Temperature Control |
| 30. | TCC | Temperature Control Contractor |
| 31. | USGBC | US Green Building Council |
| 32. | VFD | Variable Frequency Drive |

B. Definitions:

1. BACnet: The communication standards that comply with ASHRAE/ANSI standard 135-2020 and all current revisions, and are certified as such by the governing organization.

2. Control Dampers: Dampers whose operation is described in the sequence of operation of this specification, shown on a damper schedule (see drawings), or which are shown on BAS drawings.
3. Control Valves: Valves whose operation is described in the sequence of operation of this specification, shown on a valve schedule (see drawings), or which are shown on BAS drawings.
4. Furnish: The term “furnish” means to purchase and supply the part, piece or equipment.
5. Interoperability: The ability of control system components from different manufacturers to work together to provide coordinated control via real-time two-way data exchange through a common communications data exchange protocol. Interoperability shall extend to the operator’s workstation software which shall support user interaction with all control system components. Methods of interoperability include: BACnet SPC-135k.
6. Network: A system of distributed control units that are linked together on a communication channel. A network allows sharing of point information between all control units. Additionally, a network provides central monitoring and control of the entire system from any distributed control unit location. First and Second tier networks shall provide "Peer-to-Peer" communications. Third tier networks shall provide either "Peer-to-Peer", Master-Slave or Supervised Token Passing communications.
7. Open Protocol Bus (OPB): A pre-programmed communications interface that allows devices from one manufacturer to communicate and interact with those of another.
8. Provide: The term "provide" means "provide complete in place", that is, furnished and installed and ready for operation and use.

## 1.6 COORDINATION WITH OTHER TRADES (RESPONSIBILITY MATRIX)

A. The following will be provided under this specification section:

1. Installation of BAS as specified in this section.
2. Furnishing all control dampers and actuators including installation of the actuator.
3. All control valves and actuators.
4. All power and control wiring (low voltage wiring and 120/1/60 wiring) to controlled (BAS and stand-alone) components.
5. All power wiring to all BAS panels from spare or designated circuits in electrical panels (emergency power panels / central building uninterruptable power supply (UPS) when emergency power or central UPS exists or is being provided in the facility). See electrical drawings for panels and locations. When emergency power or central UPS is not available, provide an uninterruptable power supply (UPS) for the entire building automation system.
6. All miscellaneous temperature controls and field control wiring per wiring diagrams submitted by the contractor providing the equipment and control devices.
7. All integration wiring between duct smoke detector and fan starters and the BAS.
8. All communication wiring from BAS panels to third-party controller hardware and protocol coordination necessary to affect interfaces described in this specification.
9. Electrical meters at each interior lighting panel, each exterior lighting panel, each electrical panel serving HVAC equipment, each electrical panel for plug loads and receptacles. Power metering shall comply with ASHRAE 90.1-2016.
10. Natural gas meters (whole building) and submeters (boiler plant, RTUs, water heater plant, central laundry, commercial kitchen).
11. All wiring to meters and submeters.
12. A wiring from ELC as defined in this specification to connection points shown on the information technology/structured cabling drawings.

13. Provide wiring and relays between fire alarm system and destratification fans for fan shut down by the fire alarm.
14. All switched (up to and including 120/1/60) wiring to controlled components.

B. The following will be provided under the related division 23 sections:

1. Installation of all control dampers and necessary blank-off plates per the direction of the contractor installing the BAS.
2. Installation of all control valves including reducers and accessories per the direction of the contractor installing the BAS.
3. Furnishing wiring diagrams for any devices that require field wiring to manufacturer-provided control panels.
4. All hardware necessary to interface manufacturer-provided controls with the BAS. This includes all startup time and programming information necessary to affect the interface. This interface can either be a communication or hardwire interface; see this specification for details of the interfaces required.
5. Installation of all duct smoke detectors in locations shown on the drawings. Detectors provided under division 26.

C. Work provided under division 26:

1. Provide circuits at the electrical panels (emergency power when available in the facility) for powering all controllers.
2. Power wiring for all mechanical equipment.
3. All hardware necessary to interface manufacturer-provided controls with the BAS. This includes all startup time and programming information necessary to affect the interface. This interface can either be a communication or hardwire interface; see this specification for details of the interfaces required.
4. Furnishing duct smoke detectors and wiring to the fire alarm system. Detectors to be installed under division 23.

D. Products furnished but not installed under this section:

1. Hydronic Piping:

    a. Control valves
    b. Flow switches
    c. Pressure and temperature sensor wells and sockets
    d. Flow meters

2. Ductwork Accessories:

    a. Automatic control dampers
    b. Air-flow measuring stations

3. Electrical:

    a. Variable frequency drives

E. The following “RESPONSIBILITY MATRIX” will be used to define division of responsibility between the contractors and vendors involved with this project:

| WORK | FURNISH | INSTALL | LOW VOLT WIRING / CONDUIT | LINE POWER WIRING/ CONDUIT |
|---|---|---|---|---|
| | | | | |
| **General** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| BAS low voltage and communication wiring | TCC | TCC | TCC | N/A |
| BAS conduits and raceways | TCC | TCC | TCC | N/A |
| 120/1/60 power from Electrical Panel to BAS panels | TCC | TCC | N/A | TCC |
| BAS controllers, enclosures, panels | TCC | TCC | TCC | TCC |
| Piping wells, hydronic diff pressure switches | TCC | 23 | TCC | N/A |
| | | | | |
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| | | | | |
| | | | | |
| **Electrical Systems** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| Wiring between main switchboard and BAS | TCC | TCC | TCC | N/A |
| Wiring between Emerg. Gen. and BAS | TCC | TCC | TCC | N/A |
| Wiring between ATSs and BAS | TCC | TCC | TCC | N/A |
| Wiring between lighting control panel and BAS | TCC | TCC | TCC | N/A |
| | | | | |
| **Hot Water / DHW Systems** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| HW Pump VFDs | 23 | 26 | TCC | 26 |
| Control valves | TCC | 23 | TCC | TCC |
| Wiring between kill switch and boilers | TCC | TCC | TCC | TCC |
| DHW control valves (on HW side) | 22-Plbg | 22-Plbg | TCC | N/A |
| DHW pump control | 22-Plbg | 22-Plbg | TCC | 22-Plbg |
| Boiler misc. controls | 23 | TCC | TCC | 26 |
| | | | | |
| **Chilled Water System** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| Control valves | TCC | 23 | TCC | TCC |
| Wiring between chillers and BAS | TCC | TCC | TCC | TCC |
| Proprietary-to-LON interface – chiller | 23 | factory | N/A | N/A |
| | | | | |

| | | | | |
|---|---|---|---|---|
| **AHU** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| OA, RA, EA, isolation and cross-over dampers | TCC | 23 | N/A | N/A |
| Damper actuators | TCC | TCC | TCC | TCC |
| Control valves | TCC | 23 | TCC | TCC |
| Duct smoke detectors | TCC | 23 | TCC | TCC |
| Supply and Return Fan VFDs | 23 | 26 | TCC | 26 |
| Air flow measuring stations | TCC | 23 | TCC | N/A |
| humidifiers | 23 | 23 | TCC | 26 |
| | | | | |
| | | | | |
| **Terminal Unit** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| FPBs and VAV boxes | 23 | 23 | TCC | 26 |
| Terminal Unit controls (including primary air damper actuator, $CO_2$ and humidity sensors, override button) | TCC | TCC | TCC | TCC |
| Terminal Unit RHC valves | TCC | 23 | TCC | TCC |
| FTR valves | TCC | 23 | TCC | TCC |
| | | | | |
| **Exhaust Fans** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| EF controls | TCC | TCC | TCC | TCC |
| EF VFDs | 23 | 26 | TCC | 26 |
| Relay/contactors (as required for 1-ph and 3-ph) | TCC | TCC | TCC | 26 |
| Relay/contactors for light switch status | TCC | TCC | TCC | 26 |
| EF barometric backdraft dampers | 23 | 23 | N/A | N/A |
| Exhaust air and outside air Motorized dampers | TCC | 23 | TCC | TCC |
| Motorized damper actuators | TCC | TCC | TCC | TCC |
| | | | | |
| **UH and CUH** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| controls | TCC | TCC | TCC | TCC |
| CUH automatic valves | TCC | 23 | TCC | TCC |
| CUH aqua stat | TCC | 23 | TCC | TCC |
| | | | | |
| **Computer Room Units** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| Interlock wiring | TCC | TCC | TCC | 26 |
| Monitor points between HVAC components and BAS | TCC | TCC | TCC | TCC |
| | | | | |
| **Fan Coil Units** | **Furnish** | **Install** | **Low Volt** | **Line Power** |
| FCU controls | TCC | TCC | TCC | TCC |
| FCU automatic valves | TCC | 23 | TCC | N/A |

| Miscellaneous | Furnish | Install | Low Volt | Line Power |
|---|---|---|---|---|
| Wiring between Fire Pump and BAS | TCC | TCC | TCC | N/A |
| Wiring between kitchen exhaust hood fire protection and associated make up air source (make-up air unit fan safety circuit / starter, zone vav box, etc.). | TCC | TCC | TCC | TCC |
| Wiring between kitchen hood system controller and associated kitchen exhaust fan and make-up air unit | TCC | TCC | TCC | TCC |
| Wiring between main water meter and BAS | TCC | TCC | TCC | N/A |
| Wiring between irrigation meters and BAS | TCC | TCC | TCC | TCC |

1.7 APPROVED SYSTEM INTEGRATORS AND MANUFACTURERS

A. Compliance: Acceptable contractors and manufacturers will be determined based upon compliance with the terms of the specifications.

B. Technical Proposal: All prospective contractors will submit a Technical Proposal in accordance with Part 1 of this specification representing their compliance with the specification.

C. Installing Contractor Requirements: The acceptable contractor will meet the following requirements.

1. Experience: Have a minimum of five (5) years experience in the installation and service of BAS comparable in size and scope to the system to be installed on this project.
2. Quality Assurance: Meet all of the requirements of the Quality Assurance section of Part 1 of this specification and document this compliance in a Technical Proposal as described in Part 1 of this specification if requested by the Using agency, Architect or Engineer.
3. References: Submit a list of reference projects as noted in the Quality Assurance section of Part 1 of this specification if requested by the Using agency, Architect or Engineer.
4. Documentation: Provide documentation of training received by proposed project personnel on the installation, servicing, programming and designing of open protocol systems using BACnet, LON or equivalent open standard that is applied to this project. This training documentation will include any certification received from the governing body of the open standard or designated entity of the governing body.

D. Manufacturer Requirements: The acceptable manufacturer will meet the following requirements.

1. Compliance with all applicable sections of this specification.
2. Letter of compliance with the governing body of the open protocol used by the manufacturer.
3. Listing of a product or manufacturer does not in and of itself imply or suggest that the product or manufacturer meets the applicable requirements of the specification.

E. Acceptable system manufacturers include:

1. Johnson Controls – Non-proprietary line. Native Bacnet. Programmable through Workbench. Tridium Niagra N4.
2. Automated Logic Chicago –Non-proprietary line. Native Bacnet. Programmable through Workbench. Tridium Niagra N4.
3. Control Engineering Corp – Non-proprietary line. Native Bacnet. Programmable through Workbench. Tridium Niagra N4.
4. Precision Controls – Non-proprietary line. Native Bacnet. Programmable through Workbench. Tridium Niagra N4.
5. Automated Building Controls (ABC) Non-proprietary line. Native Bacnet. Programmable through Workbench. Tridium Niagra N4.
6. Honeywell - Non-proprietary line. Native Bacnet. Programmable through Workbench. Tridium Niagra N4.

F. Listed systems integrators can use only products that comply with the requirement for BACnet communications as noted in this specification. Systems which employ proprietary controller communication at any level (ELC/SLC/ASC) will not be considered.

## 1.8 QUALITY ASSURANCE

A. The installing Contractor shall be experienced in the installation of the specified DDC control systems and shall, at the request of the Using agency, Architect or Engineer, submit prior to bid, as part of a technical proposal as described in Part 1 of this specification a list of no fewer than five (5) installations completed in the previous 18 months that demonstrate the level of expertise in the field. The system shall be installed by competent mechanics, and electricians regularly employed by the installing Contractor, or regularly sub-contracted by BAS Contractors with full responsibility for proper operation of the BAS including debugging and proper calibration of each component in the entire system. The Contractor shall have an in-place support facility within the Chicagoland area, with technical staff, and all necessary test and diagnostic equipment to provide full support of the installed BAS.

1. At least two of the references must be completed projects that demonstrate the use of a standard Internet browser (such as Netscape or Internet Explorer) as a means to access information from the BAS without the use of proprietary hardware, software or interface devices.
2. At least three of the reference installations must be completed projects that demonstrate the integration of products from at least three manufacturers on either the first tier (ELC as defined in Part 2 of this specification) or second tier (SLC or ASC as defined in Part 2 of this specification). Integration must be demonstrated without the use of gateways, workstations, or proprietary hardware or software. Controllers from multiple manufacturers must reside on the same network bus, they must communicate using a standard protocol, and the operator must be able to communicate with each controller through the use of a standard Internet browsing software (such as Netscape or Internet Explorer).
3. References shall demonstrate the contractor's compliance with the Approved System Integrators and Manufacturer's portion of Part 1 of this specification.

B. The controllers and other controller-related products of the Building Management System shall be as specified in this specification. Any substitutions must be approved, in writing, via addendum by the Engineer after the receipt of a Technical Proposal in accordance with Part 1 of this specification.

C. The DDC System Installation shall consist of all necessary electric and DDC control and sensing devices as required and all accessories and electric wiring to fulfill the intent of this Specification. All equipment to be furnished as part of this work shall be new and in conformance with all applicable standards and codes; unless noted otherwise elsewhere in the documentation.

D. ISO-9001

1. The manufacturer of the Building Automation System shall provide documentation supporting compliance with ISO-9001 (Model of Quality Assurance in Design/Development, Production, Installation, and Servicing). Product Literature provided by the BAS manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar. Manufacturers delivering products that do not comply with the ISO-9001 certification requirement shall provide the following information to assure that quality systems are in place which are equivalent to the ISO-9001 standard:

    a. Marketing Specification Standards
    b. Design File Standards
    c. Manufacturing Test Standards
    d. Calibration Standards
    e. Quality System Standards
    f. Quality System Procedures
    g. Documented management commitment that all employees participate in quality programs
    h. Training Procedures
    i. Methods by which corrective actions are taken for problems identified within the factory process.

E. Codes And Approvals

1. The complete TC installation shall be in strict accordance with the national and local electrical codes and the electrical section of these specifications. All devices designed for or used in line voltage applications shall be UL Listed.
2. All electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

F. All system components shall be fault tolerant.

1. Provide satisfactory operation without damage at 110% and 85% of rated voltage and at +/- 3 hertz variation in line frequency.
2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be AC coupled or equivalent so that any single device failure will not disrupt or halt bus communication.
3. All real time clocks and volatile data files shall be battery backed up.

1.9 TECHNICAL PROPOSAL

A. Any requests to substitute products differing from those listed in this specification shall be done in the form of a Technical Proposal submitted no fewer than 7 business days prior to bid.

B. The Technical Proposal will include at a minimum:

1. List of all proposed equipment or substitutions including specific part numbers.
2. Detailed manufacturer data sheets.
3. Description of every aspect in which the proposed or substituted devices differ from the specified device.
4. A summary statement of how the proposed system will function or how the substitution will impact the design of the system and its installation.
5. For all substitutions, a list of exemptions, clarifications, and deviations from the specification.
6. For DDC controllers and software, examples of custom programs, graphic screens, and service tools required.
7. A riser diagram of the proposed system including indication of communication protocols employed at each level of communication.

C. The Engineer will review all Technical Proposals and will provide a written response within 10 business days.

## 1.10 CODES AND STANDARDS

A. All work, materials and equipment shall comply with rules and regulations of all codes and ordinances of the local, state and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions of the following codes that were in effect 30 days prior to receipt of bids:

1. National Electric Code (NEC)
2. International Building Code (IBC)
3. International Mechanical Code (IMC)
4. City of Chicago Building Code (CBC)
5. ComEd (Commonwealth Edison Company “DG” Blue book-Co gen)
6. International Energy Conservation Code (IECC 2018)
7. ASHRAE 135 2020
8. ASHRAE 90.1 2016

B. Provide electrical products which have been tested, listed and labeled by UL.

C. Comply with NEMA standards pertaining to components and devices for electric control systems.

D. Comply with NFPA 90A “Standard for the Installation of Air Conditioning and Ventilating Systems” where applicable to controls and control sequences.

E. All BAS central equipment shall be UL916 listed.

F. All electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

## 1.11 SUBMITTALS

A. General:

1. All submittals to be done in accordance with the requirements of the submittals section of Division 0 of this specification.
2. Contractor to provide shop drawings and all other submittal information on all hardware, software and installation to be provided.
3. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the drawings, specifications, and design intent.
4. Provide an electronic pdf of any submittal information.
5. All drawings shall be prepared on a CAD system that produces drawing files compatible with AutoCAD (latest edition) and be provided minimum 11"X17" sheets.

B. Cut Sheets/Data Sheets:

1. Submit a cut sheet or data sheet for each device referenced in the shop drawings.

    a. When a manufacturer's cut sheet or data sheet applies to a product series rather than a specific product, the data specifically applicable to the device used on the project shall be indicated by an arrow pointing at that data on the cut sheet or data sheet.
    b. If ordering options are indicated on a cut sheet or data sheet, and one or more of those options are being provided on the device for this project, clearly mark those options with an arrow or circle the data on the data sheet or cut sheet.

2. Cut sheets section of the submittal must have numbered or labeled tabs separating different sections.

    a. No tabbed section shall have more than 20 pages, unless a single product data sheet itself exceeds 20 pages.
    b. Tabbed separation of the cut sheet / data sheet section shall be done in a logical manner. For example, all temperature and humidity sensors in one tab, pressure switches and transmitters in one tab, DDC controllers in one or more tabs, etc. Note: no more than 20 pages per tab.

3. Cut sheets section of the submittals shall have a table of contents. Include the following information in the cut sheet / data sheet table of contents:

    a. Name of manufacturer (example – Veris)
    b. Full manufacturer's product number, including options if applicable (example – Hawkeye 708)
    c. Short description of device (example – Solid core adjustable current status sensor)
    d. Tab under which the cut sheet or data sheet can be found (example – Tab 7)
    e. HVAC equipment tag that the device is applied to (example – AHU-1, 2, 3)
    f. Quantity of device used on this project (example – Quantity 6)

C. Shop Drawings – Submit job specific shop drawings, the drawings shall include the following as a minimum:

1. Riser Diagram(s)
2. Floor Plan Diagrams(s)
3. Equipment Schematics (Custom Showing All Components)
4. Wiring Diagrams
5. Panel Diagrams
6. Points Lists

7. Bill of Materials
8. Sequences of Operation
9. Damper Schedule
10. Valve Schedule
11. Air Flow Measuring Station Schedule
12. Meter Schedules

D. Riser Diagrams – Include riser diagrams showing the following:

1. All DDC controllers connected via communications bus
2. All computers, servers, gateways, router, hubs, Ethernet switches that are part of the BAS.
3. All third-party devices connected to the BAS via protocol interface (VFDs, chillers, etc.)
4. Paths of communication buses
5. Each segment of each communication bus shall be clearly identified as to type of communication (e.g., , MS/TP proprietary, BACnet MSTP, BACnet/Ethernet, ArcNet, etc.)

E. Floor Plans – Include floor plan diagrams showing the following:

1. General outline of building and rooms. Include room numbers if a device is located in that room.
2. Location of major HVAC equipment controlled by the BAS
3. Location of control panels connected via communications buses
4. Location of application specific controllers not located in a control panel
5. Location of computers, servers, gateways, router, hubs, Ethernet switches, etc. that are not located in a control panel
6. Location of power feed for each control panel
7. Actual path of communications buses
8. Each segment of each communication bus shall be clearly identified as to type of communication (e.g., LonWorks, MS/TP proprietary, BACnet/Ethernet, ArcNet, etc.)
9. Location of sensors.

F. Equipment Schematics – Include equipment schematic diagrams showing the following:

1. Major components in the HVAC equipment being represented. For example, an AHU/RTU/MAU would show, as a minimum (as applicable):

    a. Supply and return/relief fans, VFDs
    b. Heating, reheating, dehumidifying and cooling coils
    c. Energy recovery components
    d. Valves, dampers, actuators
    e. Temperature, pressure, and humidity sensors
    f. Filter differential pressure switches/sensors
    g. Any miscellaneous items such as, but not limited to freeze stats, high/low pressure safeties, smoke detectors,

2. DDC points in the HVAC equipment being represented. Include the following information:

    a. Point name
    b. Controller address

c. Point number on controller

3. Direction of airflow, water flow, as applicable
4. Normal / failsafe positions of dampers and valves.

G. Wiring Diagrams – Include wiring schematic diagrams showing the following:

1. DDC Controllers with I/O terminals, power terminals, and communication terminals
2. Any expansion modules connected to main DDC controller
3. Devices being controlled by DDC controller or expansion modules
4. Control power transformers
5. Any terminal strips used in the point-to-point wiring
6. Actual point-to-point wiring between controller and device (Note: References to generic wiring details are not acceptable).
7. Terminal numbers on external devices
8. Any wiring between devices (hardwired interlocks)

H. Panel Diagrams – Include panel diagrams showing the following:

1. Control Enclosure shown to scale
2. Location of DDC controller (shown to scale) within control enclosure
3. Location of control power transformers within enclosure
4. Location of any terminal strips within enclosure
5. Location of any wire duct within enclosure
6. Location of any other devices such as pressure switches, relays, contactors, etc., within enclosure

I. Points Lists – Include points lists showing the following:

1. Point name
2. Point tag as used in programming (if different from common point name)
3. Controller address
4. Controller terminal number
5. Point description
6. HVAC unit being controlled
7. Point type (DI, DO, AI, AO, UI, UO). For universal points, also indicate whether used as analog or digital.
8. Signal type (thermistor, RTD, 4-20 mA, 0-10 vdc, dry contact, etc.)
9. Units (°F, psig, % open, on/off, normal/alarm, clean/dirty, etc.)
10. Field device description
11. Field device manufacturer
12. Field device model number

J. Bill of Materials– Include Bill of Materials showing the following:

1. Point name
2. Point tag as used in programming (if different from common point name)
3. Point description
4. HVAC unit being controlled
5. Signal type (thermistor, RTD, 4-20 mA, 0-10 vdc, dry contact, etc.)
6. Field device description
7. Field device manufacturer

8. Field device model number
9. Quantity

K. Control Damper Schedule – Include control damper schedule showing the following:

1. Damper Tag
2. System
3. Service
4. Gross Opening Size (w x h)
5. Free Area Opening Size (w x h)
6. Design Flow Rate (in CFM)
7. Design Free Area Velocity (in FPM)
8. Design Air Pressure Drop (inches of WC)
9. Selected Damper Size (w x h)
10. Section Labels & Sizes (w x h)
11. Manufacturer
12. Part Number
13. Blade Pattern (parallel, opposed, single)
14. Blade Type (e.g., air foil, two piece)
15. Bearing Type
16. Fail Position (de-energized)
17. Actuator Model Number
18. Actuator Quantity
19. Actuator Working Range (in volts, mA or psi as applicable)
20. Actuator Mounting Location (electronic; shaft, sleeve-out collar channel support, duct, wall, floor, jack shaft)
21. Damper Closing Torque
22. Actuator Rated Torque
23. Damper Close-Off Pressure (against system).
24. Comments
25. For dampers provided by others, but where actuators are provided under this section, include these dampers in the schedule, noting they are provided by others.

L. Control Valve Schedule – Include control valve schedule showing the following:

1. Valve Tag
2. System
3. Service
4. Piping System Pressure Rating
5. Pipe Size
6. Body Pattern (e.g., straight thru mixing, diverting)
7. Load (coil) Flow Rate (in GPM or lbs/hr)(actual from submittals)
8. Load (coil) Pressure Drop (in PSI) (actual from submittals)
9. Desired Valve Pressure Drop
10. Calculated Valve Cv
11. Selected Valve Cv
12. Actual Valve Pressure Drop (in PSI)
13. Manufacturer
14. Part Number
15. Body Style (e.g., globe, butterfly, ball)
16. Pressure rating of valve body
17. Size (in inches)

18. Operating/Dynamic pressure rating of valve
19. Pipe Connections (sweat, screwed, flanged)
20. Fail Position Flow Pattern (de-energized) (e.g., open, closed, last position, thru coil, bypass coil)
21. Actuator Model Number
22. Actuator Working Range (in volts, mA or psi as applicable)
23. Actuator Close-Off Pressure (against system)

M. Sequence of Operation – Include sequence of operation showing the following:

1. Detailed sequence of operation showing all modes of operation and algorithms. Any references in the sequence to hardware or software points will include the actual point names as they will be shown in the user interface.
2. Exact copies of the sequence from this specification are not acceptable.
3. Example of design sequence of operation versus TC submittal sequence of operation:

   a. Design Sequence of Operation: Provide a freeze-protection thermostat to disable the fan, close the OA and EA dampers, open the RA damper, and open the HW coil valve whenever the mixed air temperature is below 40°F
   b. Temperature Control Sequence of Operation: The freeze stat is hardwired to disable the supply fan, close the OA and EA dampers, open the RA damper, and open the HW coil valve whenever the mixed air temperature is below 40°F. The freeze stat contact is normally closed when temperature is greater than 40 °F, and opens when the temperature is below 40 °F. Through relay logic (see wiring diagram on page xx),

      1) The SF-VFD is disabled by breaking a contact to its safety circuit.
      2) The OA and EA dampers open (RA damper closes) by killing power to the actuators, dampers return to their normal positions.
      3) The HW valve opens by killing power to the valve actuator, valve moves to its normal open position

N. Airflow Measuring Station (AFMS) Schedule – Include airflow station schedule showing the following:

1. AFMS Tag (use design tag if applicable)
2. System (example – AHU-1)
3. Service (example – outside air)
4. Duct Size (w x h)
5. Design Flow Rate (in CFM)
6. Design Velocity (in FPM)
7. Maximum Allowable Flow Rate, Velocity, and Accuracy (in CFM, FPM, and %)
8. Minimum Allowable Flow Rate, Velocity, and Accuracy (in CFM, FPM, and %)
9. Manufacturer
10. Model / Part Number
11. AFMS Type (differential pressure, thermal anemometer, etc.)

O. Meter Schedule (CHW, CDW, HW, ST, CD, Power, etc.) – Include meter schedule showing the following:

1. Flow Meter Tag (use design tag if applicable)
2. System (example – Chilled Water)

3. Service (example – Secondary Loop Return)
4. Pipe Size
5. Design Flow Rate (in GPM, etc.)
6. Design Velocity (in FPS, etc.)
7. Maximum Allowable Flow Rate, Velocity, and Accuracy (in GPM, FPS, and %)
8. Minimum Allowable Flow Rate, Velocity, and Accuracy (in GPM, FPM, and %)
9. Manufacturer
10. Model / Part Number
11. Meter Type (turbine, electromagnetic, thermal, vortex, etc.)
12. Temperature sensors where applicable
13. Pressure where applicable
14. Interface type.

P. Trending Data Storage Estimates:

1. Provide a conservative estimate of the total number of hardwired points included in the BAS.
2. Approximate the required hard drive storage space to maintain long term storage of all points, trended in 5-minute increments for a total of two (2) years.

Q. Installation Checklists:

1. Provide job specific point-to-point checklists that will be used for field verification of BAS devices.

R. Alarms:

1. Provide an alarm schedule noting (for each alarm in the system):

a. Description
b. Priority
c. Time Delay
d. Auto/Manual Reset
e. Limit Levels (for analog alarms)

S. Miscellaneous – Include the following items:

1. Descriptions of methods for performing field quality control during the installation process.
2. Include a conservative estimate of the number of points in the building automation system (including hard points, virtual points, setpoints, etc.), and the approximate hard drive storage space required to maintain long term storage of all points, trended in 5-minute increments for a total of 5 years.
3. Description of methods of testing and verifying integrity of installation after it has been completed, as well as checklists and report formats that will be used to comply with the "Demonstration and Acceptance" portion of Part 3 of this specification.
4. An alarm schedule noting (for each alarm in the system): description, operator action required, priority, time delay, auto/manual reset, limit levels (Analog Alarms), whether the operator can disable the alarm, paging code.

## 1.12 WARRANTY

A. All components, parts and assemblies supplied by the Contractor shall be guaranteed against defects in materials and workmanship for a period of time as defined above in Specific Requirements.

B. The Contractor shall respond to the using agency's request for warranty service within 24 hours during normal business hours. If a malfunction of a component covered by the warranty causes an issue, failure, etc. that requires immediate attention (e.g., no heat to the building), then the contractor will be required to respond within 4 hours and cover all costs for premium time.

C. Labor to troubleshoot, repair, or replace system components shall be furnished by the Contractor at no charge to the Using agency during the construction and warranty period.

D. At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Engineer, the Engineer shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.

E. Exception: The Contractor shall not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The Contractor shall warrant all installation materials and labor, however, and shall demonstrate that all reused devices are in operating condition at the time of acceptance by the Engineer.

F. If the using agency receives substantial use of a phase of the project prior to completion of the entire project, the Contractor can request that the portion being used receive a phased acceptance. If the Engineer and using agency agree, then the warranty period for this phase of the project will begin at the date of phased acceptance. However, this does not relieve the Contractor of fully commissioning this phase of the work, and if, during the final phase of commissioning, demonstration or acceptance, an error is found in the phase of the installation under substantial use, and this error is attributable to the installation by the Contractor, then the Contractor will correct this error at no cost to the using agency regardless of the status of the warranty for that phase of work.

1.13 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed software and documentation shall become the property of the using agency. These include, but are not limited to:

1. Project graphic images
2. Record drawings
3. Project database
4. Project-specific programming code
5. All documentation

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations. This installation shall not be used as a test site for any new products unless explicitly approved by the using agency's representative in writing.

B. Spare parts shall be available for at least five years after completion of the contract.

2.2 COMMUNICATION ARCHITECTURE

A. The system will utilize TCP/IP 100MB Ethernet on a new LAN installed as part of this project. All enterprise level controllers (ELC), workstations and servers will reside on this Ethernet LAN.

B. Communications among the ELCs will be TCP/IP over 100MB Ethernet. It will be full peer-to-peer communications. No exceptions to this requirement will be considered.

C. All communication between ELC and system level controllers (SLC) and between ELC and application specific controllers (ASC) will be BACnet/MS/TP, BACnet/Arcnet or LonWorks. No exceptions to this requirement will be considered. The communication network between ELC and SLC and between ELC and ASC must support similar products from other manufacturers such that the two products can reside on the network at the same time, communicate with the ELC, and provide all necessary information to the web server without the use of a Gateway. The contractor installing the BAS must show, in accordance with the Quality Assurance section of Part 1 of this specification, the at least one other manufacturer's product can reside on this network and perform as specified.

D. Communications between the server and all ELC shall be TCP/IP, XML over the 100MB Ethernet LAN.

E. Communications between the server and the workstations shall be http and HTML. All workstations will run Microsoft Internet Explorer or industry-standard browser software. The server will communicate with the ELC and serve up information to the workstations.

F. Where the ELCs (as defined in this part of the specification) do not reside on a native TCP/IP over Ethernet backbone, provide access to the system through a gateway or router provided at each ELC.

G. Every ELC must be capable of transmitting a message to a specific ELC/SLC/ASC as well as to all ELC/SLC/ASC.

H. All messages transmitted must be positively acknowledged as received. Lack of acknowledgments shall immediately force a re-transmission of the message.

I. Error recovery and communication initialization routines are to be resident in each bus-connected device.

J. Message and alarm buffering must be present to prevent information from being lost.

K. Other than sensor/data sharing (with failure default procedures), under no circumstances shall DDC programs be LAN communications system dependent. Any DDC programs which require data from the communication system shall have default values for use in the DDC control loop in the event of failure to obtain data from the LAN communication system.

L. LAN communication system shall have fault detection capability to assist in locating breaks in the communication cable when they occur.

M. The external modem shall be capable of allowing access from a remote workstation to any ELC.

N. The LAN and ELC communications shall be multi-user, allowing operators on different workstations to talk to the same or different ELC at the same time.

## 2.3 GRAPHICAL INTERFACE SOFTWARE

A. The operator interface will be via workstations residing on the facility LAN, the facility WAN, and/or remotely over the Internet. They will run industry-standard web browser software such as Microsoft Internet Explorer 7 (or higher).

1. Graphically Based: The interface will be graphically based and allow multiple windows, viewing different part of the system, to be displayed and updated simultaneously.
2. Concurrent Users: The remote interface software shall allow for an unlimited number of concurrent users.
3. Password Protection: Provide multi-level password-protected access to the system. Definition of user passwords will be governed by the highest level of user and shall not be resident in any single workstation, but rather, in a centralized location that can be adjusted from any location by the appropriate user.
4. Functionality: Provide any operator commands, adjustability, acknowledgement or other functionality required by the sequence of operations. (i.e., Operators shall be able to adjust all setpoints, schedules, alarm limits, etc. as noted in the sequence of operation.) This includes any system parameters, time delays, deadbands, minimum/maximum values, etc. used by the contractor to accomplish the sequence of operations.
5. Trending: The system shall trend any input, output or calculated value upon operator command and provide user definable reports. Provide the trend logs and reports as noted in part 3 of this specification.
6. Alarms: Store alarms in the building controllers and report to the operator workstation as soon as the interface is established, or immediately if connection exists.

    a. Alarm Buffering: The system controllers must be able to store alarms for a minimum of 5 days without connection of the operator interface. Alarms must automatically download to a file on the operator workstation prior to the alarm buffer reaching 80% capacity. This can be accomplished by an automatic routine that notifies the user of its completion prior to clearing the buffer, or by means of an automatic prompt to the operator asking if they would like to proceed with buffer download.
    b. Alarm Descriptions: Alarms will be provided in accordance with the sequence of operations. All alarm descriptions will have default values as described in the sequence of operations, but shall be user adjustable by the highest-level user.
    c. Alarm Display: Display alarm description, time of alarm, system of alarm, current state and status of acknowledgement.
    d. Alarm Priority: Alarm priority will operate such that when multiple alarms are active, the highest priority alarms are displayed first.

7. Direct Data Exchange: System software will provide direct exchange of information into industry-standard spreadsheet and database programs such that the user can link points to the program and the point information will update automatically. Trend logs, reports and alarms shall be directly exportable to industry-standard spreadsheet and database programs.
8. Performance: All information updates and graphic loading shall be in accordance with the System Performance section of Part 1 of this specification.

9. Activity Log: Actions such as schedule adjustment, password changing, setpoint adjustment and alarm acknowledgement will be logged by user performing the action, time and date of action.

10. The remote interface will be via the Internet through workstations running industry-standard web browser software such as Microsoft Internet Explorer, etc. The remote interface shall allow for an unlimited number of concurrent users. The user interface shall provide simple and easy to use graphics for changing room temperature and other necessary setpoints. The web interface shall be based on HTML5 for access from any web browser including Apple OSX without the addition of JAVA plug-ins or client-based apps.

    a. Below is a partial list of requirements for Graphics:

        1) The user interface shall provide simple and easy to use graphics for changing room temperature and other necessary setpoints. The web interface shall be based on HTML5 for access from any web browser including Apple OSX without the addition of JAVA plug-ins or client-based apps.
        2) The new system shall be web based using only BACnet IP and BACnet MSTP protocols, with all new BACnet MSTP controllers as specified herein.
        3) All controllers shall be BTL Listed and using open BACnet standard. JACE products must be open, and controllers must have ILC or similar open certification in addition to BTL listing. FOX proprietary protocol for IP networks in not acceptable, Niagara AX in not acceptable, and must be BACnet IP.
        4) All controllers used on the project shall open BACnet capable of full communication with any manufacturer's open JACE 8000 or BACnet IP client without any gateways, tools, or additional licensing. e.g., Honeywell controllers must be independently licensed (ILC) for True open BACnet communication.
        5) Provide complete and easy to use color graphics user interface, including:

            a) A unique 3d graphical representation or all equipment with adjustable setpoints and alarms
            b) 3D - Floor Plans with zones identified and color coding of alarm conditions (flood fill red for above setpoint, blue for below setpoint).
            c) Provide room numbers and equipment tags for all equipment on plans
            d) Navigation tree for access to all equipment and plans
            e) Clicking on any floor plan equipment tag will navigate to unique equipment graphic
            f) All setpoints shall have user adjustable alarm ranges
            g) Time of day scheduling for all equipment easily adjustable by the user.
            h) Adjustable Alarm ranges and alarm history page

B. The system will employ a web server that resides on the LAN. This server will serve up the pages read through the industry-standard web browser.

1. The server will serve up all of the graphics and data needed to display system information on the browsers. All graphics and browsers shall be based on and use HTML – No JAVA.

2. The server may not be used as the operator workstation for the system, and will not be setup to work as a workstation for any other function.
3. The licensing of the server will allow access by up to 5 concurrent users.
4. The server shall use Microsoft Windows 10 Professional or later.
5. All information exchanged over the Internet shall be optionally encrypted and secure via SSL.
6. Graphics displayed via the browser will be those available on the BAS workstation, and will give the remote user the same functionality as the local user.
7. The web server will follow the same password protection as the local BAS access.

C. The operator interface will be installed and configured such that it will be capable of connecting to any BACnet TCP/IP product or LonWorks product that has been routed to TCP/IP. See the Integration with Third-Party Manufacturer's Equipment section of this part of the specification for more details.

D. Provide the using agency will all licenses and any source code for custom programs created for this project. Also provide a library of standard programs and programming blocks with documentation to allow for their use.

E. Integration of products from multiple vendors must not rely on a workstation or the web server. Any communication between controllers will occur via a standard protocol and will be independent of the workstation and web server. Systems that require a workstation or third-party hardware or software to link products from different manufacturers will not be permitted.

## 2.4 WEB SERVER HARDWARE

A. Provide web server with the following requirements:

1. The web server will allow concurrent access by an unlimited number of browser connections. Hardware/software solutions that have a limited number of concurrent users are NOT acceptable.
2. The web server will have two (2) LAN network cards compatible with the facility WAN and BAS LAN systems or as shown on the BAS control riser diagram.
3. The web server will reside on the facility's LAN or on a separate, independent LAN dedicated to the BAS.
4. The BAS will operate independently of the web server and shall not require the web server to be active to perform any function not specifically mentioned in this specification.
5. The web server shall support browser access via Microsoft Internet Explorer (newest version), or FoxFire (newest version).
6. The server computer will not function as the workstation. The server will provide the link between the facility LAN and the BAS LAN.
7. All information exchanged over Internet shall be optionally encrypted and secure via SSL.
8. The web server software shall have the functionality – and web server hardware shall have the hard drive capacity – to store all BAS hard point, virtual point, and setpoint trend information, trended in 5-minute increments, for a minimum of 5 years.

B. Provide a web server with the following minimum requirements:

1. Intel Core i7 960 Processor Quad Core with 3.2 GHz processor speed
2. 8.0 GB of RAM
3. Two (2) 500 GB, 7200 RPM, hard drives in RAID 1
4. 1 GB graphics card
5. Four (4) USB ports
6. Two (2) 10/100 Base-T network cards
7. 48x/24x/48x\16x CD-RW/DVD ROM Combo Drive
8. 32" wide screen flat panel color monitor
9. Full keyboard
10. Optical mouse
11. Microsoft Windows Web Server most current operating system
12. UPS backup power supply that will allow for 1 hour of workstation operation with transfer time of 2-4 ms.
13. Include original installation disks for all software, device drivers and peripherals
14. Provide software registration cards to the Using agency for all included software.

C. Provide software on this server to do the following functions.

1. Serve web pages
2. Diagnose system and controller errors
3. Generate and modify web graphics
4. Configure controllers
5. Compile and download controller programs. The controller programming language shall be a graphical, object-oriented language.

## 2.5 OPERATOR INTERFACE WORKSTATIONS

A. Provide workstations as noted in part 3 of this specification. These workstations will reside on the LAN. The BAS will operate independently of the workstation, and shall not require the operator workstation to be active to perform any function not specifically mentioned in this specification.

B. Provide a PC workstation with the following minimum requirements:

1. Intel Core i7 960 Processor Quad Core with 3.2 GHz processor speed
2. 8.0 GB of RAM
3. Two (2) 500 GB, 7200 RPM, hard drives
4. 1 GB graphics card
5. Four (4) USB ports
6. 10/1000 Base-T network cards
7. 48x/24x/48x\16x CD-RW/DVD Writer Combo Drive
8. 32" widescreen flat panel color monitor
9. Full keyboard
10. Optical mouse
11. Microsoft Windows (Most Current Version) Professional Operating System, installed, licensed
12. Microsoft Office Professional installed, licensed.
13. UPS backup power supply that will allow for ½ hour of workstation operation with transfer time of 2-4 ms.

14. Include original installation disks for all software, device drivers and peripherals
15. Provide software registration cards to the Using agency for all included software.

C. Provide software on this workstation to do the following functions.

1. Program controllers (ELC, SLC and ASC)
2. Diagnose system and controller errors
3. Generate and modify web graphics
4. Configure controllers
5. Compile and download controller programs. The controller programming language shall be a graphical, object-oriented language.

6. Interface to the using agency Supervisor – as an open BACnet gateway. When using agency provides Supervisor.

## 2.6 PRINTERS

A. Provide the following Printer:

1. 1200x1200 dpi, min 15 pages per minute color, 21 pages per minute black. 8-1/2" x 11" paper tray, inkjet or laser printer.

## 2.7 PORTABLE OPERATOR TERMINAL

A. Provide a laptop computer capable of being plugged into a port on the ELCs, SLCs and ASCs. Provide the following as a minimum:

1. Intel Core i7 960 Processor Quad Core with 3.2 GHz processor speed
2. 8.0 GB RAM (minimum)
3. Microsoft Windows (Most Current Version) Professional Operating System
4. 500 GB Hard Drive, 7200 RPM
5. 1 GB graphics card
6. Three (3) USB ports
7. 10/100 Base-T network card
8. 48x/24x/48x\16x CD-RW/DVD ROM Combo Drive
9. Integral mouse control.
10. 16" SVGA 800 x 600 resolution active-matrix display with 64K colors.
11. Carrying Case.
12. Spare battery.
13. External power supply/battery charger.
14. Include original installation disks for all software, device drivers and peripherals
15. Provide software registration cards to the Using agency for all included software.
16. Complete BAS "Service Tool software package including any hardware or software 'Keys'

B. The laptop shall utilize the BAS "Service Tool" software package and shall be configured by the contractor for remote access.

C. All workstation and laptop specifications are as of the release date of the bid documents. Any improvements in technology reasonably assumed to be available on a comparable machine at the time of installation can be requested by the engineer prior to the purchase of the equipment.

D. Terminal shall access all points connected to system ELCs, SLCs and ASCs.

## 2.8 DIRECT DIGITAL CONTROLLERS

A. There are three levels of controllers specified: ELC, SLC and ASC. See the System Performance section in Part 1 of this specification for details about control accuracy for the various controlled variables.

B. Enterprise Level Controllers (ELC):

1. ELC shall reside on the 100MB Ethernet, and communicate with BACnet TCP/IP. If the ELC is not native 100MB Ethernet, provide any necessary routers. No exceptions to these requirements will be considered.
2. The ELC shall have ports as needed to communicate with SLCs, ASCs, or any laptop computers that may be required.
3. The ELC may or may not have on-board I/O point capability. If it, has I/O, all I/O shall meet specifications for SLC I/O.
4. Each ELC shall have a static IP address.
5. Provide complete documentation of all BACnet compliance with the first submittal. (See the Submittals section of Part 1)

C. System Level Controllers (SLC):

1. SLCs or ELCs shall be used to provide all points for all equipment not specifically specified to be controlled by an ASC.
2. SLC can reside on a secondary communications bus as described in the Communications portion of Part 2 of this specification.
3. Provide complete documentation of all BACnet compliance with the first submittal. (See the Submittals section of Part 1)

D. Application Specific Controllers (ASC):

1. ASC shall be used only on “unitary” equipment such as fan coil units, VAV boxes, unit ventilators, heat pumps or for equipment where only remote enable/disable/status is required.
2. ASC can reside on a secondary communications bus as described in the Communications portion of Part 2 of this specification. The communications bus can be the same bus as the SLC; however, it does not have to be.
3. Each piece of equipment served by an ASC must have its own, dedicated ASC.
4. Provide complete documentation of all BACnet compliance with the first submittal. (See the Submittals section of Part 1)

E. ELC/SLC/ASC Common Features:

1. Manual Overrides: ELC and SLC shall have HOA switches on all digital outputs. All analog outputs shall have auto/manual switches. In the manual position there will be a potentiometer to manually adjust the output. ASC do not have to have overrides.
2. Status Indication: ELC and SLC shall have status indication. All digital outputs shall have LEDs indicating the actual status of the output (i.e., whether commanded or overridden by switch). ELC, SLC and ASC shall have an LED indicating that power is connected.

3. All control logic shall reside in ELC, SLC or ASC for all points connected to that controller. The only control logic that is dependent on another controller should be shared data (i.e., OA Temp, Enthalpy Flag, Schedules, and Electrical Demand).
4. Operator Interface: There shall be a jack for connection of a POT at each controller. The POT should be able to monitor all points on the network if connected to an ELC. At SLC and ASC, the POT should be able to monitor all local points to that controller.
5. Spare Capacity: Provide spare capacity as detailed in Part 3 of this specification. Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points.
6. Memory Back-up: Each controller should have its volatile memory backed up by a 72-hour battery. Batteries shall be lithium. In case of memory loss, all controllers shall be automatically reloaded by the operator workstation once both the controller and the workstation are active. Loss of power, memory, or communications at any controller shall generate an alarm at the workstation.
7. Internal Clock: The real time clock in all ELC shall have internal calendar with automatic leap year capability to provide time of day, day of week and date. Clocks shall operate under back-up power. Workstation backup of the internal time clock is not acceptable. If during the 72-hour backup, power is restored, the internal clock will not require the workstation to be active to reestablish the system clock.
8. Surge and Transient Protection: Isolation must be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980.
9. Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software.
10. All panel electronics shall be installed in finished steel cabinet. Interface panels shall have hinged doors and shall also contain all load relays, transducers, and associated equipment. All cabinets shall be of adequate size to accept 20% space capacity. Provide spare capacity at each cabinet for future expansions and identify quantity of spare capacity in submittal #2 as described in Part 1 of this specification. Provide one 120V duplex convenience outlet within the confines of the cabinet or adjacent to the cabinet.
11. Controllers shall be interoperable such that controllers of the same compliance class can be interchanged with the installed controller, regardless of the manufacturer. The interoperability must be capable with at least one other manufacturer's product and cannot employ routers or gateways. The interchange must be direct.

## 2.9 SYSTEM PERFORMANCE

A. The system shall conform to the following:

1. Graphic Display: The system shall display a graphic with a minimum of 20 dynamic points with all current data within 10 seconds.
2. Graphic Refresh: The system shall update a graphic with minimum of 20 dynamic points with all current data within 8 seconds.
3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
4. Object Scan: All changes of state and change of analog values will be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 6 seconds. This does not apply to information obtained from a gateway to a third-party manufacturer.

5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Performance: Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations: All workstations on the network must receive alarms within 5 seconds of each other.
9. Reporting Accuracy: The system shall report all values with an end-to-end accuracy as listed, or better, than those listed in Table 1.
10. Stability of Control: Control loops shall maintain measured variable at set point within the tolerances listed in Table 2.

## 2.10 SENSOR ACCURACIES

A. See the tables below for information about sensor accuracies. Provide calibration certificates for all sensors documenting compliance with specified accuracy and repeatability. Calibration shall, at a minimum, address 0%, 50% and 100% of signal range, and in both rising and falling of signal.

B. TABLE 1 - Reporting Accuracy

| Measured Variable | Reported Accuracy |
|---|---|
| Space Temperature | ±0.3°F |
| Ducted Air Temperature | ±0.3°F |
| Outside Air Temperature | ±0.3°F |
| Water Temperature | ±0.3°F |
| Delta-T | ±0.25°F |
| Relative Humidity | ±2%Rh |
| Airflow (Terminal) | ±3% Of Full Scale (10% To 100% Of Scale) |
| Air Pressure (Ducts) | ±0.1 In. W.G. |
| Air Pressure (Spaces) | ±0.01 In. W.G. |
| Electrical (A, V, W, Power Factor) | ±5% Of Reading (Except Utility Meters) |
| Carbon Monoxide And Dioxide | ±5% Of Reading |

C. TABLE 2 - Control Stability and Accuracy

| Controlled Variable | Control Accuracy | Range Of Medium |
|---|---|---|
| Air Pressure | ±0.2 In. W.G.<br>±0.01 In. W.G. | 0 To 6 In. W.G.<br>-0.1 To 0.1 In. W.G. |
| Airflow | ±3% Of Full Scale | |
| Space Temperature | ±0.5°F | |
| Duct Temperature | ±0.5°F | |
| Relative Humidity | ±5%Rh | |

2.11 TEMPERATURE SENSORS

A. Temperature sensors shall be Resistance Temperature Detector (RTD) type, or 10,000 Ω thermistors.

1. Accuracy of the sensor is to include all inaccuracies of the sensor, transmitter (if used), line losses, input resolution, A to D converter, and conversion equations.
2. Itemize all of these accuracies in submittals (see the Submittals section of part 1 of this specification for details).

B. Room Temperature Sensors:

1. Room temperature sensors shall be platinum RTD or nickel RTD or thermistor type.
2. Accuracy shall be ±0.5°F
3. Temperature range shall be 35°F to 140°F
4. Provide with the following options as called for per plans and /or sequence of operation:

a. RJ-11 socket for connection to BAS MS/TP communication bus
b. Digital display and local set point adjustment buttons (typical for private areas, conference rooms, etc.)
c. Momentary setback override button (typical for all areas)
d. Blank commercial type finished plate with no setpoint adjustment (typical for public areas)

5. Limits to adjustment shall be adjustable from the workstation.
6. Locking tamper / vandal proof covers in public areas.

C. Duct Temperature Sensors – Single Point:

1. Duct single point temperature sensors shall be Platinum RTDs or Nickel RTDs or thermistor type
2. Temperature range shall be -30°F to 240ºF.
3. Accuracy shall be ±0.5°F.
4. The sensor shall include a utility box and gasket to prevent air leakage and vibration noise.
5. Provide with insertion measuring probe 6” to 48” long.

D. Duct Temperature Sensors – Averaging:

1. Duct averaging temperature sensors shall be Platinum RTDs or Nickel RTDs or thermistor type with four or nine sensing elements configured in a series parallel arrangement.
2. Temperature range of -30°F to 240ºF.
3. Provide a utility box and gasket to prevent air leakage and vibration noise.
4. Accuracy shall be ±0.5°F.
5. Duct averaging sensors shall be a minimum length of two times the maximum duct dimension and shall be located to best represent the average temperature.

E. Outside Air Temperature Sensor:

1. Outside air temperature sensor shall be thin-film Platinum or Balco RTDs or thermistor
2. The temperature range shall be –40°F to 140°F minimum.

3. Provide a sun shield and weatherproof mechanically aspirated enclosure for mounting to 1/2-inch rigid conduit.
4. Mount in the outdoors on a northern exposure where air flow occurs. Mount at least 2 feet above the roof when mounted on an inside parapet wall.

F. Water Temperature Sensors:

1. Water temperature sensors shall be thin-film Platinum or Balco RTDs for all hot and chilled water temperature applications. The temperature range shall be -30°F to 245°F.
2. Provide brass thermowells and install sensor probe with heat conductive grease. Probe and sensor head shall be removable without breaking fluid seal.
3. Install sensors in top of pipe for horizontal runs and at a positive slope on vertical runs to prevent condensation from flowing to sensor head. Accuracy shall be ±1°F.

## 2.12 BINARY TEMPERATURE DEVICES

A. Line-voltage space thermostat:

1. Line-voltage thermostats shall be bimetal-actuated, snap acting SPDT contact, enclosed, UL listed for electrical rating. The thermostat cover shall provide exposed set point adjustment knob. The thermostat shall operate within the 55°F to 85°F setpoint range, with 2°F maximum differential. Locking tamper / vandal proof cover in public areas.

B. Low-temperature safety thermostat:

1. Low-temperature safety thermostats shall be manually reset, line voltage with maximum 23'-0" flexible sensing elements responsible to lowest temperature along entire length. Furnish minimum two (2) wired in series on the discharge side of the first hydronic coils (i.e., a 4-section coil requires eight low limit thermostats wired in series). Contractor to note that the operating head of such instruments shall be shielded from conditions whereby it could be activated by low temperature. Clarify location of low limits with the Engineer during submittal review if HPE Sheets illustrate a location other than the discharge side of the first hydronic coil.
2. All flexible averaging sensors shall be attached by wire ties to a suspended wire or insulated cable to prevent sensor contact with metal or other unit components.
3. Install flexible sensors across all coils at a maximum of 6” from the bottom of the bottom coil and a minimum of 7” diameter to turn the sensor. Install the detector with a maximum free distance of 12” between each pass.
4. Staggered coils shall utilize multiple sensors. Each sensor shall cover one section of the staggered coil. Sensing elements shall be a minimum of 17’ long.
5. All flexible sensors shall be protected at point of penetration of unit via a section of poly tubing to prevent contact of the sensor and the unit.
6. Mount detector within 6” of the face of the coil unless noted otherwise. For staggered coil banks, this requirement applies for each half of the bank
7. ECC to note that when any low-temperature safety controls are above an elevation 7'-0" above floor level or otherwise inaccessible, they shall employ automatic reset and shall be wired to an auxiliary control panel of a 5'-0" elevation. The control panel with piano hinged door shall utilize a latching reset relay for each individual low limit control which ensures that the fan is de-energized even as the low limit resets automatically. The panel face shall utilize a red alarm pilot light that remains lit until the 10 second time delay

reset relay momentary contact switch is activated. An LED inside the panel shall indicate which of low limits has signaled the alarm.

C. Low Temperature Limit Switches (freezestats)

1. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
2. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section.
3. Low-limit switches shall have at least three poles
4. The low temperature limit switch
5. Freeze stats shall be wired to provide three contact functions:

    a. N.C. contact hard-wired to the Supply Fan VFD safety circuits or motor starter control circuit.
    b. N.O. contact to provide an input to the BAS.
    c. N.C. contact to interrupt the 24vac power to the OA-RA-EA dampers and preheat coil valve actuators.

D. Aqua stat:

1. Strap-on type thermostats shall be provided for low or high temperature limit service on hot water or steam condensate pipes. The thermostats shall be UL listed, with a liquid-filled bulb type sensing element and capillary tubing. The thermostat shall operate within the 20°F to 120°F, or 100°F to 240°F, setpoint range, with an adjustable 6°F differential.
2. The low-limit thermostat shall be automatic reset, snap acting SPDT type with concealed set point adjustment.

## 2.13 DEW POINT / HUMIDITY SENSORS

A. Outdoor Air Dew Point Temperature

1. Dew point monitoring range -40/+115 F DP, 12% to 99% RH
2. Output signal 4-20 mA
3. Calibration adjustments zero & span
4. Factory calibration point 70 F
5. Accuracy at calibration point +2.0 Fdp
6. Protective cover. Locking tamper / vandal proof cover in public areas.

B. Space Dew Point Temperature

1. Dew point monitoring range -40/+115 F DP, 12% to 99% RH
2. Output signal 4-20 mA
3. Calibration adjustments zero & span
4. Factory calibration point 70 F
5. Accuracy at calibration point +2.0 Fdp
6. Wall mounting device with locking tamper / vandal proof cover.

C. Space Humidity Sensors:

1. Space relative humidity sensors shall be wall mounted devices that produce a linear output over the range of 5% to 90% RH.

2. The sensor shall contain an integral thermistor temperature sensing element so that both variables may be monitored via one duct mounted device.
3. Device cover color shall be white.
4. Sensor accuracy shall be ± 2% over the range of 5% to 90% relative humidity.
5. Locking tamper / vandal proof cover in patient areas.

D. Duct Humidity Sensors:

1. Duct relative humidity sensors shall be duct mounted devices that produce a linear output over the complete range of 0 to 100% RH.
2. A thin film polymer sensing element shall respond quickly to changes in humidity and shall be protected from contamination by a sintered filter.
3. The sensor shall be factory calibrated with periodic field re-calibration capability.
4. The sensor shall mount in a duct probe assembly and be installed only after the construction or renovation area is free of contamination.
5. The sensor shall also contain an integral temperature sensing element so that both variables may be monitored via one duct mounted device.
6. Sensor range shall be 0 to 100% relative humidity with an accuracy of ± 3% between 0 and 90% RH and ± 4% between 90 and 100%.

E. Outside Air Humidity Sensor:

1. Outside air relative humidity sensors shall produce a linear output over the complete range of 0 to 100% RH.
2. A thin film polymer sensing element shall respond quickly to changes in humidity and shall be protected from contamination by a sintered filter.
3. The sensor shall be factory calibrated with periodic field re-calibration capability.
4. The sensor be installed only after the construction or renovation area is free of contamination.
5. The sensor shall also contain an integral temperature sensing element so that both variables may be monitored via one weather tight device.
6. Sensor range shall be 0 to 100% relative humidity with an accuracy of ± 3% between 0 and 90% RH and ± 4% between 90 and 100%.

## 2.14 AIR AND WATER PRESSURE TRANSDUCERS

A. Air and water pressure transducers

1. General Water Pressure Transmitter Requirements:

a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in

the high and low sensing pick-up lines to allow the balancing Contractor and Using agency permanent, easy-to-use connection.

d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

2. Size transducers such that the resolution of the signal measured will be appropriate for the application.
3. Range of input signal shall not be less than 50% of the measuring range of the transmitter, and maximum value of the input signal shall not be less than 75% of the measuring range of the transmitter.
4. Acceptable manufacturers:

    a. Robinson
    b. Setra
    c. Modus
    d. Belimo

B. Filter Static Pressure Transducer:

1. Differential pressure sensors used to monitor pressure drop across air filter shall be suitable in range for the filter being monitored.
2. A complete installation kit shall be provided, including static pressure tips, tubing, and air filters.
3. Sensor output shall be 4-20 mA or 0-5 or 0-10 VDC, with single button zero and span adjustment.
4. The sensor shall have 1.0% accuracy rating
5. Sensor shall be Dwyer Series 616KD

C. Duct Static Pressure Transducer:

1. Static pressure sensors shall be electronic suitable in range for the pressure being sensed. The combined static error shall be less than plus or minus 0.5% of the full range output. Sensors shall be mounted a minimum of 2/3 the distance from fan to the area served when not specifically shown on the drawings. Sensor output shall be 4–20 ma. Sensors shall be MAMAC PR-276 or approved equal.

D. RTU/AHU Exhaust Damper and Building Differential Pressure Transducer:

1. RTU/AHU Exhaust Damper and Building Differential Pressure Transducer shall utilize a bi-directional bleed sensor. The sensor shall employ digital thermal sensing technology and be capable of accurately measuring airflow rates as low as 25 ft./min. The sensor shall be manufactured by Ebtron, Inc. Model No. - BDB3 or approved equal. Locate indoor and outdoor pressure sensors to obtain representative reading of building static pressure relative to ambient as shown on the drawings.

E. Space/Building Static Pressure Transducer:

1. Space/building static pressure sensors shall be electronic, bidirectional, with a range of +0.2” to -0.2”.
2. The combined static error shall be less than plus or minus 1.0% of the full range output.
3. The low-pressure side shall reference outdoor ambient pressure if not directed otherwise by the sequence of operation.

## 2.15 CONTROL RELAYS

A. Control relays shall be suitable for the loads encountered. Device cover shall contain information as to the wiring for both the coil and contact sides of the relay.

## 2.16 CHILLED WATER, HEATING HOT WATER, CONDENSER WATER FLOW METER (INSERTION ELECTROMAGNETIC)

A. Manufacturers: Subject to compliance with specification provide meter by Onicon, McCrometer, ABB or Johnson Controls. Bi-directional hot tap insertion electromagnetic flowmeter with integral and remote display.

B. The entire flowmeter system shall be built and calibrated by a single manufacturer, and shall consist of a flow meter (hot tap insertion), weatherproof enclosures for outdoor components and all required mechanical and electrical installation hardware. A certificate of NIST* traceable calibration shall be provided with each system. All equipment shall be covered by the manufacturer's two-year warranty from date of substantial completion.

C. Meter: The meter shall provide the following points both at the integral LCD, the remote LCD display and as outputs to the building control system: Flow Rate, Supply Temperature and Return Temperature. Output signals shall be either serial network (protocol conforming to BACnet® MS/TP, BACnet/IP, LONWORKS®, JCI-N2, MODBUS RTU RS485, MODBUS RTU TCP/IP, or Siemens-P1) and/or via individual analog and pulse outputs. Each meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required).

D. Flow Meter: Refer to meter schedule for specific flow meter type and additional requirements. The flow meter shall be installed either in the supply or return pipe of the system to be measured as shown on the documents following the manufacturer's instructions with particular attention paid to upstream and downstream straight pipe runs. Insertion type flow meters shall be provided with all installation hardware necessary to enable insertion and removal of the meter without system shutdown and shall be hand insertable up to 400 psi. For installations in non-metallic pipe, install grounding rings or probes as required.

E. Insertion Bi-Directional Electromagnetic Type: Provide Insertion Electromagnetic Flow Meter. Materials of construction for wetted metal components shall be 316 SS. For installations in non-metallic pipe, install grounding rings or probes. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 100:1. Output signals shall be completely isolated and shall consist of the following: (1) high resolution frequency output for use with peripheral devices such as a display module or Btu meter, (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable and (1) scalable dry contact output for totalization. Each flow meter shall be covered by the manufacturer's two- year warranty from date of substantial completion.

F. Installation shall comply with NEC and division 26.

G. Operating Instructions: Include complete instructions with each flow meter.

H. Install flow meter elements in accessible positions in piping systems. Install remote meter display at 5'-0" above finished floor. Coordinate location with using agency/engineer.

I. Install electromagnetic flow meters in locations where pipes will always be full of water. Provide necessary pipe accessories (flow straighteners, etc.) to install meter as required by manufacturer's recommendations.

J. Install all flow meter element types with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions. Provide necessary pipe accessories to install meter as required by manufacturer's recommendations.

K. Calibrate meters according to manufacturer's written instructions, after installation.

## 2.17 CHILLED WATER, HEATING HOT WATER, CONDENSER WATER BTU METER ASSEMBLY

A. Manufacturers: Subject to compliance with specification provide meter by Onicon, McCrometer, ABB or Johnson Controls. Bi-directional hot tap insertion electromagnetic flowmeter with integral and remote display.

B. The entire Energy Measurement System shall be built and calibrated by a single manufacturer, and shall consist of a flow meter (hot tap insertion), two temperature sensors, a BTU meter, temperature thermowells (hot tap type), weatherproof enclosures for outdoor components and all required mechanical and electrical installation hardware. A certificate of NIST* traceable calibration shall be provided with each system. All equipment shall be covered by the manufacturer's two-year warranty from date of substantial completion.

C. BTU Meter: The BTU meter shall provide the following points both at the integral LCD, remote LCD display and as outputs to the building control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. Output signals shall be either serial network (protocol conforming to BACnet® MS/TP, BACnet/IP, LONWORKS®, JCI-N2, MODBUS RTU RS485, MODBUS RTU TCP/IP, or Siemens-P1) and/or via individual analog and pulse outputs. Each BTU meter shall be factory programmed for its specific application, and shall be re-programmable using the front panel keypad (no special interface device or computer required).

D. Temperature sensors: Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched (NIST* traceable) for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within +0.15°F (including the error from individual temperature sensors, sensor matching, input offsets, and calculations).

E. Flow Meter: Refer to meter schedule for specific flow meter type and additional requirements. The flow meter shall be installed either in the supply or return pipe of the system to be measured as shown on the documents following the manufacturer's instructions with particular attention paid to upstream and downstream straight pipe runs. Insertion type flow meters shall be provided with all installation hardware necessary to enable insertion and removal of the

meter without system shutdown and shall be hand insertable up to 400 psi. For installations in non-metallic pipe, install grounding rings or probes as required.

F. Insertion Bi-Directional Electromagnetic Type: Provide Insertion Electromagnetic Flow Meter. Materials of construction for wetted metal components shall be 316 SS. For installations in non-metallic pipe, install grounding rings or probes. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 100:1. Output signals shall be completely isolated and shall consist of the following: (1) high resolution frequency output for use with peripheral devices such as a display module or Btu meter, (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable and (1) scalable dry contact output for totalization. Each flow meter shall be covered by the manufacturer's two- year warranty from date of substantial completion.

G. Installation shall comply with NEC and division 26.

H. Operating Instructions: Include complete instructions with each flow meter.

I. Install flow meter elements in accessible positions in piping systems. Install remote meter display at 5'-0" above finished floor. Coordinate location with using agency/engineer.

J. Install electromagnetic flow meters in locations where pipes will always be full of water. Provide necessary pipe accessories (flow straighteners, etc.) to install meter as required by manufacturer's recommendations.

K. Install all flow meter element types with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions. Provide necessary pipe accessories to install meter as required by manufacturer's recommendations.

L. Calibrate meters according to manufacturer's written instructions, after installation.

2.18 DISPLACEMENT-TYPE WATER METERS:

A. Manufacturers subject to compliance with specification requirements: Neptune with TriconE3, Badger Meters, Elster Group GmbH.

B. Standard: AWWA C700.

C. Pressure Rating: 150-psig working pressure.

D. Body Design: Nutating disc; totalization meter.

E. Registration: In gallons.

1. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

a. System shall be capable of transmitting data using AMR/AMI technology.
b. System shall be capable of transmitting data to Building Automation System.

F. Case: Stainless steel.

G. End Connections: Threaded or flanged.

H. Installation shall comply with NEC and division 26.

I. Operating Instructions: Include complete instructions with each flow meter.

J. Install flow meter elements in accessible positions in piping systems. Meter display at 5'-0" above finished floor. Coordinate location with using agency/engineer.

K. Install all flow meter element types with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions. Provide necessary pipe accessories to install meter as required by manufacturer's recommendations.

L. Calibrate meters according to manufacturer's written instructions, after installation.

## 2.19 NATURAL GAS METER

A. Natural Gas Submeter: Provide a Thermal Mass Flow Meter, complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand-insertable up to 60 psi. Provide a flow conditioner if required to meet the manufacturer's minimum upstream straight pipe run requirement. For pipe sizes smaller than 1½ inch provide an inline thermal mass flow meter. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall provide SFPM* flow readings from a pair of encapsulated platinum sensors and shall not require additional temperature or pressure compensation. In addition, the meter shall allow for field validation testing of the current calibration and provide for a printed validation test report. Each flow meter shall be individually wet-calibrated against a standard that is directly traceable to NIST**. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 500-7000 SFPM and ± 2% of rate from 100-500 SFPM. Overall turndown shall exceed 1000:1. Output signals shall consist of the following: (1) analog 4-20mA output and (1) additional output that is factory configured as either a totalizing pulse or an RS485 interface for connection to a BACnet MS/TP or Modbus RTU serial network. The meter shall be equipped with an integrally mounted display with a user interface that allows for field programming of the meter. In addition to the integral display, provide a remote display mounted 5'-0" above finished floor. Coordinate location with using agency / engineer. Each flow meter shall be covered by the manufacturer's two-year warranty from date of substantial completion.
*Standard Feet per Minute. ** National Institute of Standards and Technology.

B. Acceptable Manufacturers:

1. Onicon
2. ABB
3. Magnetrol

C. Natural Gas Utility Meter: Provide replacement meter assembly (meters/valves/regulators/piping/bollards/pad/etc.) for the existing building meter with new Peoples Energy approved 2-pulse utility meter. One pulse for the utility to utilize and the second pulse output for BAS monitoring. Coordinate with natural gas utility (Peoples Energy).

## 2.20 AIR FLOW MEASURING STATIONS

A. Air Flow Measuring Stations – General

1. Air Measuring Stations to be furnished under this section of the specification and installed under Division 23 Section 233300, Duct Accessories.

B. Outside Air Measuring Stations:

1. General:

a. Airflow measuring station (AFMS) shall use the principle of thermal dispersion.
b. Each AFMS shall consist of multiple sensing nodes each with one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor, hermetically sealed and potted in a marine grade waterproof epoxy.
c. Each AFMS shall be provided with a remotely located microprocessor-based transmitter and one or more sensor probes, with each probe contain one or more independently wired sensing nodes. Provide one (1) sensor node for each square foot of area, up to a maximum of 16 nodes.
d. Probe internal wiring connections shall be sealed and protected from the elements and suitable for direct exposure to water.

2. Performance:

a. Each sensing node shall have an airflow accuracy of ±2% of reading over an operating range of 0 to 5,000 FPM. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.
b. Each sensing node shall have a temperature accuracy of ±0.15° F over an operating range of -20° F to 160° F.
c. Airflow measurement shall be field configurable to determine the average actual or standard mass airflow rate.
d. The transmitter shall be capable of determining the average airflow rate and temperature of the sensor nodes.

3. Interface:

a. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display
b. Analog output signals shall provide the total airflow rate and average temperature.
c. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals and one isolated RS-485 (field selectable BACnet MS/TP or Modbus AHU) network connection.

4. The manufacturer's authorized representative shall visit the site, coordinate and approve placement and the operating airflow rates for each measurement location and verify installation/operation.
5. Acceptable Manufacturers:

    a. Ebtron – GTx116
    b. Air Monitor – Electra-Flo
    c. Johnson Controls – AD-1272

C. Duct Mounted Air Measuring Stations:

1. General:

    a. Airflow measuring station (AFMS) shall use the principle of thermal dispersion.
    b. Each AFMS shall consist of multiple sensing nodes each with one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor, hermetically sealed and potted in a marine grade waterproof epoxy.
    c. Each AFMS shall be provided with a remotely located microprocessor-based transmitter and one or more sensor probes, with each probe contain one or more independently wired sensing nodes. Provide one (1) sensor node for each square foot of area, up to a maximum of 16 nodes.
    d. Probe internal wiring connections shall be sealed and protected from the elements and suitable for direct exposure to water.

2. Performance:

    a. Each sensing node shall have an airflow accuracy of ±2% of reading over an operating range of 0 to 5,000 FPM. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.
    b. Each sensing node shall have a temperature accuracy of ±0.15° F over an operating range of -20° F to 160° F.
    c. Airflow measurement shall be field configurable to determine the average actual or standard mass airflow rate.
    d. The transmitter shall be capable of determining the average airflow rate and temperature of the sensor nodes.

3. Interface:

    a. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display
    b. Analog output signals shall provide the total airflow rate and average temperature.
    c. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals and one isolated RS-485 (field selectable BACnet MS/TP or Modbus AHU) network connection.

4. The manufacturer's authorized representative shall review, approve placement and the operating airflow rates for each measurement location indicated on the plans.
5. Acceptable Manufacturers:

a. Ebtron – GTx116
b. Air Monitor – Electra-Flo/S5-CM
c. Johnson Controls – AD-1272

D. Fan Inlet Air Measuring Stations:

1. General:

a. Fan inlet airflow measuring station (AFMS) shall use the principle of thermal dispersion.
b. Each fan inlet AFMS shall consist of multiple sensing nodes each with one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor, hermetically sealed and potted in a marine grade waterproof epoxy.
c. Each fan inlet AFMS shall consist of 2 probes (one sensor per probe) for each fan inlet. For DWDI fans, provide 2 probes on each of the fan's inlet (4 probes total). For fan arrays, provide pair of probes for each fan inlet.
d. Probe internal wiring connections shall be sealed and protected from the elements and suitable for direct exposure to water.

2. Performance:

a. Each sensing node shall have an airflow accuracy of ±2% of reading over an operating range of 0 to 10,000 FPM. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.
b. Each sensing node shall have a temperature accuracy of ±0.15° F over an operating range of -20° F to 160° F.
c. Airflow measurement shall be field configurable to determine the average actual or standard mass airflow rate.
d. The transmitter shall be capable of determining the average airflow rate and temperature of the sensor nodes.

3. Interface:

a. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display
b. Analog output signals shall provide the total airflow rate and average temperature.
c. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals and one isolated RS-485 (field selectable BACnet MS/TP or Modbus AHU) network connection.

4. The manufacturer's authorized representative shall review, approve placement and the operating airflow rates for each measurement location indicated on the plans.
5. Acceptable Manufacturers:

a. Ebtron
b. Air Monitor
c. Johnson Controls

2.21 STATUS SWITCHES

A. Status and Safety Switches

1. General Requirements: Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BAS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment as specifically noted in this specification, as stated on the drawings, or as required by the sequence of operations of this specification.

B. Current Sensing Switches

1. The current sensing switch shall be self-powered with solid state circuitry and a dry contact output. It shall consist of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

    a. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
    b. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
    c. When monitoring variable speed loads, sensors shall be self-calibrating, designated by the manufacturer for variable speed loads, and shall detecting belt loss or flow down to 34 Hz.

C. Air Filter Status Switches

1. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
2. A complete installation kit shall be provided, including static pressure tips, tubing, fittings, and air filters.
3. Provide appropriate scale range and differential adjustment for intended service.

D. Air Flow Switches

1. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
2. Acceptable manufacturers: Johnson Controls, Cleveland Controls, Belimo.

E. Air Pressure Safety Switches

1. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
2. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
3. Acceptable manufacturers:

    a. Johnson Controls,
    b. Cleveland Controls

c. Belimo

F. Water Flow Switches:

1. Description: measures the pressure difference between two sources: supply lines and return lines. A change in differential pressure will reposition the switching mechanism to cause corrective action of the supplementary control equipment.
2. Brass Bellows, completely enclosed contact mechanism, heavy-duty elements with high overrun pressure.

G. Water level switches:

1. Water level switches shall be self-contained ball floats designed to be suspended from their cords. Contacts shall be normally open.

H. Damper position and valve position switches:

1. Damper position and valve position switches shall have adjustable trip levels. Switches that are integral to actuators shall have adjustable trip settings and be capable of indicating either open and closed position, or both. Damper position switches that mount directly to the dampers must be mechanically activated, and must not contain mercury.

I. Low Temperature Limit Switches

1. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
2. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section.
3. Low-limit switches shall have at least three poles
4. The low temperature limit switch shall be: Johnson Controls A70, Honeywell, Schneider Electric or Siemens.

J. Low-temperature Protection Thermostats:

1. Provide low-temperature protection thermostats (freezestats) of manual-reset type, with one normally open (NO) and one normally closed (NC) contact. Provide thermostat designed to operate in response to coldest 16" length of sensing element, regardless of temperature at other parts of element. Provide multiple freezestats wired in series in cases where the standard sensing element is not long enough to sufficiently cover the entire coil face. Support element properly to cover entire duct width. Freezestat shall be Johnson Controls A11D, Honeywell, Schneider Electric or Siemens.

2. Freeze stats shall be wired to provide three contact functions:

a. N.C. contact hard-wired to the Supply Fan VFD safety circuits or motor starter control circuit.
b. N.O. contact to provide an input to the BAS.
c. N.C. contact to interrupt the 24vac power to the OA-RA-EA dampers and preheat coil valve actuators.

## 2.22 SMOKE DETECTORS

A. Ionization Smoke Detectors:

1. For each air-handling unit / roof top unit / make up air unit, provide UL-listed ionization smoke detectors in main supply and return air ducts as shown on Control Diagram.
2. Smoke detector shall be compatible with the project / building fire alarm system. Coordinate with fire alarm provider.
3. Smoke detector shall be furnished under this section and installed under Division 23.
4. Each Smoke detector shall be furnished with three isolated contacts. One N.C. contact will be wired to shut down the supply and return fans; the second shall be N.O. and provide an input to the BAS, the third shall be N.O. and provide an input to the fire alarm. Wiring to fire alarm by fire alarm provider.

## 2.23 CARBON MONOXIDE SENSORS

A. Carbon Monoxide Sensor

1. Minimum sensor range shall be 0 – 200 PPM, microprocessor controlled.
2. Sensor shall be capable of analog output of 4-20mA, 0-5 or 0-10 VDC
3. Provide sensor with LED indicators to display normal and alarm conditions.
4. Sensor element must be replaceable
5. Incorporate an audible alarm.
6. provide one normally open and one normally closed auxiliary contact for customer use.
7. Acceptable manufactures:

    a. MSA
    b. Engelhard
    c. Vulcain

## 2.24 CARBON DIOXIDE SENSORS

A. Carbon Dioxide Sensor

1. Minimum sensor range shall be 0-2000 PPM, microprocessor controlled.
2. Accuracy of 3% of the reading +/- 50ppm; suitable over a temperature range of 32 to 122 degF.
3. Sensor shall be capable of analog output of 4-20mA, 0-5 or 0-10 VDC
4. NDIR Sensor with stainless steel wire mesh filter with dual channel calibration for duct mounting. Dual channel calibration shall incorporate a single infrared beam with two detectors incorporating different optical filters. One filter shall measure the wavelength region absorbed by CO2 and the other filter shall measure the wavelength region not absorbed by CO2. Dual channel NDIR calibration shall be once every 24 hours. ABC Calibration Logic utilizing a single beam shall not be acceptable.
5. For duct mounted sensing, provide sampling tubes and accessories as required by the manufacturer to provide the necessary accuracy.
6. Acceptable manufactures:

    a. MSA
    b. Engelhard
    c. Vulcain
    d. Belimo

2.25 NITROGEN DIOXIDE SENSORS

A. Nitrogen Dioxide Sensor

1. Sensor range shall be 0 – 10 PPM, microprocessor controlled.
2. Sensor shall be capable of analog output of 4-20mA, 0-5 or 0-10 VDC
3. Sensor shall have LED indicators to display normal and alarm conditions.
4. Sensor shall have LCD digital display showing measurement of NO2 in ppm with a display resolution of 0.2 ppm
5. Sensor element must be replaceable
6. Incorporate an audible alarm of minimum of 82 dBA at 10 ft distance
7. Provide one normally open and one normally closed auxiliary contact for local control of devices as defined in the sequence of operation.
8. Acceptable manufactures:

    a. MSA
    b. Engelhard
    c. Vulcain
    d. CRC

2.26 REFRIGERANT DETECTION SYSTEMS:

A. Refrigerant detection system

1. Manufacturers: General Analysis Corporation, CRC, MSA, or Yokogawa.
2. Infrared type refrigerant detection and alarm systems detecting refrigerant in listings at adjustable detection points to provide both visual and audible alarms. System shall use internal pump, and required filters, for extracting samples from remote locations.
3. System shall conform to ANSI/BSR ASHRAE Standard 15-2016 Safety Code for Mechanical Refrigeration.
4. Sensor shall be compound specific and calibrated for refrigerant used in chillers. System shall be automatically zero at set intervals by sensing air from and uncontaminated air source. Auto zero cycle may be manually or remotely initiated.
5. Latched alarms shall be capable of being reset locally by remote contact closure. System malfunction alarm shall be non-latching contact annunciated locally and remotely.
6. System shall require no more than annual recalibration and monthly confirmation of clean air source for auto-zero.
7. Provide local alarm and control panel to accept these inputs and provide outputs for warning alarm and critical alarm, which shall energize emergency ventilation system. Both alarms shall have DPDT relays and shall energize local horn-strobe alarm and also provide for connection to Using agency's control system.
8. Refrigerant leak detection system to have the following minimum performance.

    a. Minimum Enclosure Rating: NEMA 4
    b. Power: 120 VAC/60 Hz
    c. Operating Temperature: 60°F to 105°F (15°C to 40°C)
    d. Operating Humidity: 10% to 90% RH
    e. Contact Ratings: 5 amp 120 VAC
    f. Contact(s): 2 sets DPDT independently configured for different concentrations.
    g. Performance:

h. Minimum measurable: 1 ppm as tested per UL2075
i. Response time: 20 seconds at 99%
j. Accuracy: Error < ± 2% full scale
k. Operating Temperature: 0 to 120°F
l. Display: 3-digit LED or LCD displaying refrigerant gas concentration
m. Display Range: 0-100 ppm
n. Output: 4-20 mA/24VDC

9.

| Refrigerant | Warning Alarm Point | Critical Alarm Point |
|---|---|---|
| R123 | 15 ppm | 30 ppm |
| R134a | 200 ppm | 300 |

2.27 OCCUPANCY SENSORS

A. Description: Wall mounted, dual technology (ultrasonic/microphonics and passive infrared) motion sensor.

1. Dual dry contacts / relay (one for building automation use and a second for other/lighting control use)
2. Wall mounted extended range 180-degree sensing. Quantity as required to cover zone as recommended by manufacturer.
3. Dual LED indicators (Green ultrasonic/microphonic motion, red passive infrared motion)
4. Wall mounting kit.
5. 24 volt / 4 mA
6. Unit / finish plate color as selected by architect
7. No field calibration / adjustment required.
8. Time Delay: adjustable time delay, to prevent false operation.
9. Title 24, UL listed
10. Power pack included.
11. 5-year warranty from date of substantial completion
12. Acceptable manufactures:

a. Lutron
b. Leviton
c. Lithonia Lighting.

B. Description: Ceiling mounted, dual technology (ultrasonic/microphonics and passive infrared) motion sensor.

1. Dual dry contacts / relay (one for building automation use and a second for other/lighting control use)
2. Ceiling mounted extended range 360-degree sensing. Minimum 2000 SF coverage per unit. Quantity as required to cover zone as recommended by manufacturer.
3. Dual LED indicators (Green ultrasonic/microphonic motion, red passive infrared motion)
4. Ceiling mounting kit. Coordinate with ceiling type.
5. 24 volt / 4 mA
6. Unit / finish plate color as selected by architect
7. No field calibration / adjustment required.
8. Time Delay: adjustable time delay, to prevent false operation.
9. Power pack included.
10. 5-year warranty from date of substantial completion

11. Acceptable manufactures:

    a. Lutron
    b. Leviton
    c. Lithonia Lighting.

## 2.28 LIGHT LEVEL SWITCHES

A. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, microprocessor input, and complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.
5. Acceptable manufactures:

    a. Intermatic, Inc.
    b. Lithonia Lighting.
    c. Novitas, Inc.
    d. Paragon Electric Co.
    e. Square D.
    f. TORK.
    g. Watt Stopper (The).

## 2.29 CONTROL DAMPERS AND ACTUATORS

A. Size all dampers and actuators for the appropriate application and submit this information on a damper schedule as noted in the Submittals section of part 1 of this specification.

B. All 2-position control dampers shall be sized for the greater of the duct size connected or a maximum of 0.05” WC air pressure drop at maximum design airflow and fully open position. Dampers shall be flanged type (in duct not acceptable). Provide smooth duct transitions to accommodate dampers larger than connected ductwork.

C. All modulating control dampers shall be sized by the contractor installing the BAS to allow for proper control authority and pressure drops.

D. All control dampers shall be low leakage type.

1. Leakage shall be no more than 1% at 1500 FPM approach velocity at 4" static closing torque. Submit leakage and flow characteristics for all control dampers. Standard air leakage data to be certified under the AMCA certified ratings program.
2. Damper blades to be opposed blade extruded aluminum profiles. Blade ends to be capped in order to seal hollow interior and minimize air leakage possibilities. Outside air and exhaust air damper blades and frames shall be aluminum and fully insulated.
3. Blade gaskets and frame seals shall be extruded silicone. Gaskets to be secured in an integral slot within the aluminum extrusions.
4. No blade shall be greater than 8" width or 48" length, and dampers shall be available for either opposed or parallel blade action.
5. Frames shall be 14-gauge galvanized steel. Outside air and exhaust air damper blades and frames shall be aluminum and fully insulated.
6. Dampers to be designed for temperatures ranging between -40° F and 212° F, and shall have a pressure drop of a full open 48" X 48" damper shall not exceed 0.2"w.g. at 1000 fpm.
7. Dampers shall be "Flanged to Duct", and installation of dampers shall be in accordance with manufacturer's installation guidelines.

E. Damper actuators shall be electronic as manufactured by Belimo, Johnson Controls, Siemens or Schneider Electric in compliance with the requirements below..

1. Actuators shall be direct-couple type capable of mounting to a damper shaft up to 1.05" O.D. without the need for linkages.
2. Modulating actuators shall have true analog signal (2-10VDC). PWM or floating point control is not allowed. Selecting of direct/reverse action relative to signal shall be accomplished by a switch mounted on the actuator, and shall not require opening the housing.
3. Actuators shall fail closed on loss of power for all OA and EA applications. Closing time shall be less than 30 seconds.

    a. Mechanical spring return mechanism shall drive controlled device to an end position (open or close) upon loss of power.
    b. Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors. The power fail position shall be proportionally adjustable between 0 to 100% in 10% increments with a 2 second operational delay.
    c. Changing of failsafe direction shall not require removal or reinsertion of drive mechanism.

4. Actuators on isolation dampers shall have integral end switch to prove damper open.
5. Provide for manual positioning of the damper actuator without power and without disconnection the actuator from the damper.

F. Acceptable Damper Manufacturers:
1. TAMCO, Series 1500 (return air), Series 9000 (outside air and exhaust/relief air)
2. Ruskin Series CD-50 (return air), Series TED-50 (outside air and exhaust/relief air)
3. Johnson Controls Series VD-1250 (return air), Series VD-1251TI (outside air and exhaust/relief air)

2.30 CONTROL VALVES AND ACTUATORS - (2 POSITION, 3-WAY AND DUAL TEMP CHANGEOVER CONTROL VALVES)

A. Control valve assemblies shall be provided and delivered from a single manufacturer as a complete assembly.

B. Size all valves and actuators for the appropriate application and submit this information on a valve schedule as noted in the Submittals section of part 1 of this specification.

C. Provide factory-fabricated electronic control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system. Except as otherwise indicated, provide valves which mate and match material of connecting piping. Equip control valves with control valve motors, and with proper shutoff ratings for each individual application.

1. All automated control valves shall be characterized control, ball, globe or butterfly as specified. Piping geometry correction factors (Fp) must be used when sizing ball valves. The Cv or corrected Cv rating of all valves shall be stated on the submitted valve schedule. The flow type for all two-way valves shall be equal percentage or modified equal percentage. Flow type for three-way valves shall be linear. All valves shall have a minimum resolution of 80:1.
2. Unless otherwise stated, two position steam valves shall be sized for 10% of the available pressure and two position water valves for 2 PSI or less. Use line size valves if the pressure is not known. Modulating water valves shall be sized to provide a maximum 5 PSI pressure drop across the valve.
3. Butterfly valves are acceptable for all two position applications, for modulating larger flow applications (3” or larger), or where the close-off rating of other valves does not meet the design requirements. A C v factor of sixty (60) degrees shall be used for sizing modulating butterfly valves and ninety (90) degrees for two (2) position butterfly valves. Fluid velocity limits must be adhered to based on the manufacturer’s recommendations.
4. Provide individual valve tagging of up to 45 characters (location/service/unit, etc.) on each valve. Valve tags shall be documented on the approved valve schedule.
5. The manufacturer shall warranty all valve assemblies for a period of 5 years from date of substantial completion, with the first 2 years unconditional or as stated elsewhere in the specifications.
6. The manufacturer’s recommendations shall be followed with regard to mounting, locating insulation, and applying the products.
7. Subject to compliance all electronic valve assemblies including the valve body and respective valve actuator shall be one of the following manufacturers:

    a. Belimo
    b. Johnson Controls
    c. Siemens
    d. Schneider Electric

D. Characterized Control Valves-All Water Services

1. Characterized Control Valves (CCV) shall be used for all water applications where sizing permits.
2. A Teflon® PTFE flow-characterizing disc shall be installed in the inlet of 2-way and in the control port of 3-way valves. The valve trim shall utilize a stainless-steel ball and

stem for all water or glycol solutions up to 60%. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1 ¼" shall be rated at 600 psi and sizes 1 ½ to 2" at 400 psi with a temperature range of 0 to 250 deg F. The maximum allowable pressure differential shall be 50 psi for on/off and 50 psi for modulating service.

3. CCVs shall have a self-aligning, blowout proof, bronze stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon® seats and seals shall be used.
4. The valves shall have an ISO-mounting flange and provide a 4 position, field changeable, electronic actuator mounting arrangement. A non-metallic, coupling shall provide a direct, mechanical, connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate stem forces. A vent hole shall be provided to reduce condensation build-up.
5. Subject to compliance all electronic valve assemblies including the valve body and respective valve actuator shall be one of the following manufacturers:

    a. Belimo
    b. Johnson Controls
    c. Siemens
    d. Schneider Electric

E. Electronic Globe Control Valves - All Services:

1. Two- and Three-Way Screwed Valves: Valves 1/2 inch through two inches shall be bronze body, NPT screw type, and shall be rated for ANSI Class 250 working pressure. The operating temperature range shall be 20 to 250 deg F. Valve stems shall be stainless steel. Valve plugs shall be brass or bronze for water service and stainless steel for steam service, depending on temperature and pressure requirements. Stem packing shall be EPDM O-ring, TFE or EP-V rings or EPT. All valves shall be rated for a maximum water differential of 35 PSI.
2. Two- and Three-Way Flanged Valves: Valves 2-½ inch and above shall be cast iron or cast carbon steel, flanged, and shall be rated for ANSI Class 125 working pressure. The operating temperature range shall be 32 to 250 degrees F. Valve stems shall be stainless steel. Valve plugs shall be brass or bronze for water service. All valves shall be rated for a maximum water differential of 25 PSI.
3. Subject to compliance all electronic valve assemblies including the valve body and respective valve actuator shall be one of the following manufacturers:

    a. Belimo
    b. Johnson Controls
    c. Siemens
    d. Schneider Electric

F. Electronic Ball Control Valves - All Services:

1. Ball valves may in all applications where sizing dictates a 2-way valve 3" or less or a 3-way valve 2" or less. Standard ball valve sizes and Cv ratings must be stated and determined based on actual port sizes. Ball valves that approximate Cv ratings by mechanically limiting port openings or stroke are unacceptable. Three-way ball valves may be used in either mixing or diverting applications.
2. Ball valves shall be furnished with a stainless-steel ball and stem. All ball valves shall have reinforced Teflon seats and packing and female NP threads. Two-way bodies up to 3" shall be rated for 600 PSI WOG, cold, non-shock, service. Three-way bodies up to 2"

shall be rated for 400 PSI WOG, cold, non-shock, service. The valves shall have a self-aligning, blowout proof, stem design with a glass-reinforced Teflon thrust seal washer, and a stuffing box ring with minimum rating of 400 PSI. Each valve shall be tested by the manufacturer, air under water, at each end of travel. The valve shall be re-packable and the stem packing gland shall be adjustable to compensate for wear.

3. All ball valves shall incorporate either an anti-condensation thermal break cap in the stem or be designed to reduce heat transfer to the actuator. Bodies will be rated for continual use at greater than 350 degrees. F. Additional thermal separators shall be provided between the mounting bracket and actuator to allow complete free air movement and minimize heat transfer to the actuator.
4. Provide insulation casings for chilled water ball valves up to 2.5" in size.
5. Subject to compliance all electronic valve assemblies including the valve body and respective valve actuator shall be one of the following manufacturers:

    a. Belimo
    b. Johnson Controls
    c. Siemens
    d. Schneider Electric

G. Electronic Butterfly Control Valves:

1. Valve bodies shall be the full lug-wafer style, drilled and tapped. The body shall feature and extended neck allowing sufficient clearance for flanges and piping insulation. Assemblies shall have a minimum rangeability of 40 to 1. The disc shall be aluminum/bronze or SS for low pressure steam applications.
2. The disk shall have full 360-degree concentric seating. A torque plug shall provide a positive leak-proof connection of the disc to the stem. The seat shall be heavy duty with molded-in O-rings creating a positive seal between flange face and valve body. No gaskets shall be required between the valve and flange faces. The resilient seat shall provide bubble tight shutoff in either direction with the disc closed. The seat shall be field replaceable.
3. Subject to compliance all electronic valve assemblies including the valve body and respective valve actuator shall be one of the following manufacturers:

    a. Belimo
    b. Johnson Controls
    c. Siemens
    d. Schneider Electric

H. Valve Motor Actuators: Size each motor to operate valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified.

1. Low torque, electronic valve actuators (defined as less than 300 in-lb. of Torque) shall be NEMA 2 rated, fully proportional (4-20 mA or 2-10 VDC), pulse width, floating/tri-state, two position, or as required. Upon loss of control signal, a proportional, non-spring return, valve actuator shall fail open or closed based on the desired zero position. Upon loss of power, a non-spring return, actuator shall maintain the last position. When required, valves shall operate in sequence with other devices by using programmable, multifunction technology (MFT) or built-in sequencing devices. Manual override handles shall be provided for all non-spring return actuators. Valves used for terminal

equipment such as re-heat coils, radiant panels, radiation, cabinet and unit heaters, etc. and coils not directly exposed to outside air shall use non-spring return actuators unless otherwise specified. All heating coils such as preheat coils, air handling unit heating coils, unit ventilators, fan coils, etc. exposed directly to outdoor air, shall use power failure, spring return, safety actuators. Chilled water coils using a glycol mix to prevent freezing shall use non-spring return actuators.

2. For power failure/safety applications, where specified, valves shall require either a mechanical spring return or an electronic fail-safe incorporating an active balancing circuit to maintain equal charging rates among the Super Capacitors. All low Torque, spring return actuators shall be capable of CW or CCW rotation by changing the mounting orientation.
3. Proportional low Torque actuators shall be positive positioning, responding to a 2-10 VDC or 4-20 mA signal, shall include a visual valve position indicator, a built-in direction of rotation reversing switch, and an actuator generated 2-10 VDC electronic feedback signal, independent of the input signal. This signal will provide a DDC input signal or drive another actuator. Low Torque actuators incapable of tandem operation are not acceptable. Low Torque actuator(s) shall have the capability of adding auxiliary switches if required. Power shall be 24 VAC or VDC for proportional actuators and 24 or 120 VAC for 2 position spring return actuators. A 3-foot cable shall be provided for easy installation to a junction box.
4. All actuator(s) shall provide minimum torque required for valve close off with an approximate run time of 95 seconds for full rotation. The close off minimums shall be, 200 PSI for Characterized Control valves, 75 PSI for ball valves, 25 PSI for globe valves, and 50 PSI for butterfly valves. Low Torque actuators shall be designed with current limiting, digital motor rotation sensing circuits or adjustable end of travel switches to provide motor protection. Tandem actuators shall be used as required Actuators using a single bolt or a single set screw fastening techniques are not acceptable.
5. Modulating, non-spring return actuators shall have a direction of rotation switch, conduit fittings, and a release button or actuator movement feature to allow for manual override. All low Torque actuators shall be capable of being mechanically or electrically paralleled to increase torque if required.
6. Low Torque valve actuators shall be minimum NEMA 2 rated. Subject to compliance actuators shall be one of the following: Belimo Air Controls, Delta Control Products, Siebe or Dodge Engineering.
7. Valves requiring over 300 in-lb. of Torque, or for high close-offs, shall be furnished with tandem low Torque actuators or may be furnished with an industrial high Torque actuator. Subject to compliance actuators shall be one of the following: Belimo Aircontrols, Raymond Control Systems (RCS), Delta Control Products, or Dodge Engineering and shall include the following:

    a. Resolution of the modulating motor of 1%.
    b. A pre-wired 6’ pigtail.
    c. Field changeable, printed circuit boards to provide either 2-position or modulating operation. Modulating versions shall include an onboard digital controller with an LCD display capable of programming input and output signals, shaft rotation, and direct or reverse action.
    d. The actuator shall have a resolution of 100:1 and a running time of 30to 60 seconds per 90 degrees.
    e. 24 or 120 VAC (50/60 Hz) power supply options. Two SPDT auxiliary switches shall be provided.
    f. Torque ratings as required for the application. The standard housing shall have a NEMA 4 rating. Optional housings with NEMA 7 or 9 ratings will be available.

g. A permanently attached or detachable, manual override hand wheel shall be provided for use in the event of power failure or malfunction. When in manual, electrical power will be interrupted. The hand wheel will not rotate while to actuator is being electrically driven. Override handles requiring the use of a wrench or push to override mechanisms are not acceptable
h. Provide a built-in thermostat and heater to prevent condensation.

2.31 CONTROL VALVES AND ACTUATORS - (ALL OTHER HYDRONIC CONTROL VALVES)

A. Control valve assemblies shall be provided and delivered from a single manufacturer as a complete assembly.

B. Size all valves and actuators for the appropriate application and submit this information on a valve schedule as noted in the Submittals section of part 1 of this specification.

C. Subject to compliance valves 3/4" and less, shall be Belimo Zone Tight Pressure Independent Zone Valves (PIQCV), Flow Control Industries, and Siemens. Valves shall be rated for fluid type and 150% of the system operating pressure and temperature.

1. A flow-characterizing disc incorporated within the ball shall be installed in the stainless-steel ball The valve trim shall utilize a stainless-steel ball with an internal characterizing disc and stem for all water or glycol solutions up to 60% incorporating a dual EPDM O-ring packing design with fiberglass reinforced Teflon® seats and seals. Bodies rated at 360 psi with a maximum media temperature limit of 250 deg F.
2. The valve shall incorporate an internal pressure regulator located upstream of the ball to regulate pressure and maintain a constant pressure differential. Replaceable cartridges are not permitted. The valve shall operate within a pressure differential range of 5 to 50 psi with a flow control tolerance of +/- 5%. Two internal P/T ports shall be incorporated for differential pressure verification.
3. The flow characteristic shall be equal percentage.
4. The actuator shall attach directly to the valve requiring no tools.

D. Subject to compliance valves 1" to 6" valves use Belimo Electronic Pressure Independent Control Valves (ePIV), Flow Control Industries (DeltaPValve) and , Siemens. Valves shall be rated for fluid type and 150% of the system operating pressure and temperature

1. A characterized control valve shall be integrated with an ultrasonic flow meter (accuracy +/- 2%) providing analog flow feedback. The valve shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential of 1 to 50 psi. The ultrasonic flow meter shall incorporate an algorithm to automatically compensate for the glycol concentration.
2. A Teflon® PTFE flow-characterizing disc shall be installed in the inlet of the characterized control valve. The valve trim shall utilize a stainless-steel ball and stem for all water or glycol solutions up to 60%. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1 ¼" shall be rated at 600 psi and sizes 1 ½ to 2" at ANSI 125, Class B with a temperature range of 14 to 250 deg F. The maximum allowable pressure differential shall be 50 psi.
3. The flow characteristic shall be equal percentage.

E. Subject to compliance valves larger than 6" parallel Belimo Electronic Pressure Independent Control Valves (ePIV), Flow Control Industries (DeltaP Valve), Siemens. Valves shall be rated for fluid type and 150% of the system operating pressure and temperature.

F. For valves larger than 8" use butterfly valve with appropriate actuator.

1. Valve bodies shall be of the full lug-wafer style, drilled and tapped. The body shall feature and extended neck allowing sufficient clearance for flanges and piping insulation. Assemblies shall have a minimum resolution of 40 to 1. The disc shall be aluminum bronze or stainless steel for steam applications.
2. The disc shall have full 360-degree concentric seating. A torque plug shall provide a positive leak-proof connection of the disc to the stem. The seat shall be heavy duty with molded-in O-rings creating a positive seal between flange face and valve body. No gaskets shall be required between the valve and flange faces. The resilient seat shall provide bubble tight shutoff in either direction with the disc closed. The seat shall be field replaceable and not bonded to the valve.
3. Subject to compliance all electronic valve assemblies including the valve body and respective valve actuator shall be one of the following manufacturers:

    a. Jamesbury
    b. Adams
    c. Bray

G. Modulating actuators shall have true analog signal (2-10VDC). PWM or floating-point control is not allowed (the exception to this is VAV reheat applications). Selecting of direct/reverse action relative to signal shall be accomplished by a switch mounted on the actuator and shall not require opening the housing.

H. Actuators shall fail open on loss of power for all hot water applications. Closing time shall be less than 30 seconds.

1. Changing of failsafe direction shall not require removal or reinsertion of drive mechanism.

I. Provide for manual positioning of the valve actuator without power and without disconnection the actuator from the valve.

2.32 FAN POWERED VAV, VAV BOX AND CAV BOX CONTROLLERS:

A. FPB, VAV boxes shall be furnished and installed under specification Division 23 Section 233600.

B. Direct digital controller and actuator shall be furnished under this section and mounted on FPB, VAV and CAV boxes under specification Division 23 Section 233600.

C. Contractor shall provide the controllers, actuators, sensors and miscellaneous hardware necessary to ensure a complete functional system. The components shall be supplied to the box manufacture in sufficient time to ensure factory installation and wiring of all devices. The factory installation of the BAS components shall not interfere with the timely delivery of the boxes.

D. Two-way heating control valves for these boxes fail position shall be last position.

2.33 VARIABLE FREQUENCY DRIVES:

A. Provide variable frequency drives (VFDs) for variable air volume fans, constant volume fans (where noted for balancing) and pumps as shown/scheduled on plans and defined in Responsibility Matrix above.

B. See Specification Section 230923.01 for specification of variable frequency drives.

2.34 TRANSFORMERS AND POWER SUPPLIES

A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

B. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.

1. Unit shall operate between 32ºF and 120ºF. EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration.
2. Line voltage units shall be UL recognized and CSA approved.

2.35 KW TRANSDUCER

A. KW transducer shall be used in simple power monitoring applications. Transducers shall meet the following criteria.

1. Materials: Encased copper
2. Rating: 600 VAC
3. Mounting: Split Core
4. Range: Up to 2400amps
5. Accuracy: +/- 1%
6. Output: 4-20mA

2.36 ELECTRICAL POWER TRANSDUCER

A. Electrical power transducer shall be used in simple power monitoring applications. Transducers shall meet the following criteria.

1. On three-phase applications, measure voltage and amperage on all three phases.
2. Operating Voltage Range: 80% - 120% of nominal
3. Power Line Frequency Range: 45 to 60 Hz
4. Amperage Rating: Based on circuit(s) being monitored
5. CT Mounting: Split Core
6. Accuracy: +/- 1%

7. Operating Temperature Range: 32°F to 140°F
8. Operating Relative Humidity: 0-(95)% non-condensing
9. Output Type: LonWorks or Modbus networked
10. Power: Line Powered

B. Quantities Measured:

1. kWh – Totalized Energy Consumption
2. kW - Real Power
3. kVAR – Reactive Power
4. kVA – Apparent Power
5. Power Factor
6. Voltage – line-to-line
7. Voltage – line-to-neutral
8. Amperage – Average
9. Frequency

C. Manufacturers Subject to Compliance with the Specification:

1. CCS – WattNode Plus
2. Veris – Enercept Enhanced Data Stream Power Transducer
3. Shark

## 2.37 CURRENT TRANSFORMERS (CT)

A. The current transformers shall be designed to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.

1. The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.
2. The current transformers shall meet the following specifications:

a. Frequency Limits: 50 to 400 Hz.
b. Insulation: 0.6 KV Class, 10 KV BIL.
c. Accuracy: 1% at 10% to 130% of rated current.
d. Range 1-10 Amps minimum, 20-200 amps maximum
e. Trip Point adjustable
f. Output 0-5 VDC

3. Provide a disconnect switch for each current transformer.
4. Protection: 250 A max current.
5. Subject to compliance all CTs shall be one of the following manufacturers:

a. Ohio
b. Semitronics Technologies Inc.
c. Triad Technologies
d. EMON
e. Hawkeye
f. Continental Control Systems

## 2.38 ELECTRICAL SUBMETERING

A. The sub-metering device will monitor current and voltage on all three phases and provide a pulse output.

B. Accuracy: ±1% from 7% to 100% of rated current (temperature range 0-60C)

C. Transducer: Conform to ANSI C12.1 metering accuracy standards.

D. Output: Pulse with field selectable pulse per kWh.

E. Mounting: In panel or as indicated on the drawing

F. Subject to compliance all electrical submeters shall be one of the following manufacturers:

1. Eaton Pow-R-Line IQ35M
2. Veris Enercept H8036
3. E-Mon D-Mon Class 3200 Smart Meter

## 2.39 ELECTRICAL SUBMETER

A. Electrical submeter device will monitor current and voltage on all three phases

B. Provide current transducers of appropriate size based on wire size and expected amperage draw

C. Data shall be transmitted via open protocol communication using Modbus RTU

D. The following information shall be made available to the BAS:

1. Total Consumed Power (kWh)
2. Current, 3-Phase Average (A)
3. Current, Per Phase (A)
4. Voltage, 3-Phase Average (V)
5. Voltage, Per Phase (V)
6. Power, 3-Phase Real (kW)
7. Power, 3-Phase Reactive (kW)
8. Power, 3-Phase Apparent (kW)
9. Power Factor, 3-Phase

E. Subject to compliance all electrical submeters shall be one of the following manufacturers:

1. Eaton Pow-R-Line IQ35M
2. Veris Enercept H8036
3. E-Mon D-Mon Class 3200 Smart Meter

## 2.40 DIGITAL ENERGY MONITOR - ELECTRICAL

A. Self-contained microprocessor-based digital energy monitor includes a set of three current transformers and voltage transducers and processing capabilities.

B. Provide appropriate size based on current draw.

C. Voltage range from 208 V to 480 V with fused leads

D. Split core current transducers

E. Consumption value continuously accumulated and retained during power outages

F. Information Provided:

G. Consumption, kWh

H. Demand, kW (3-phase total)

I. Apparent power, kVA (3-phase total)

J. Reactive power, kVAR (3-phase total)

K. Power factor effective

L. Voltage, line-to-line and line-to-neutral

M. Current, 3-phase average and for each phase

2.41 INTEGRATION WITH THIRD-PARTY MANUFACTURER'S EQUIPMENT

A. Provide the third-party interfaces as noted in part 3 of this specification. Interfaces will map all points noted on the drawings or required by the project sequence of operation as a minimum, and all points available from the controller as a maximum. If a point listed in the project sequence of operation or the drawing cannot be integrated through the interface, then the contractor is responsible to provide the hardware/software/programming and connect the point to the BAS through a hard-wired input or output. If more points are available than are listed either on the drawings or as required by the specifications/sequence, then submit the available points for selection by the Engineer. Include the discovering/mapping/showing on the graphic an additional 10 points per piece of equipment that will be chosen from during construction by the using agency, engineer or commissioning agent.

B. All interfaces between the BAS and other equipment are the responsibility of the contractor installing the BAS. The equipment supplier is responsible for the proper performance of their equipment, for coordinating equipment requirements with the contractor installing the BAS prior to equipment submittals, and for providing a startup technician on-site during the establishment of the interface.

C. BACnet or LonWorks compliant ELC or manufacturer-provided controls

1. For controllers to be installed, provide any information necessary to the using agency to allow another BACnet compliant device to be directly connected to the existing network, and send/receive information to the system installed under this specification. The system shall then read and present the information made available by the third-party system, and transmit information receivable by the third-party system. This shall be accomplished by user configuration of point information, but shall not require recompiling or downloading of control programs.

D. Non-BACnet or LonWorks compliant ELC or manufacturer-provided controls

1. Provide programming and hardware necessary to integrate information from the existing controllers as noted in parts 3 and 4 of this specification.
2. For each system to be connected, provide a separate ELC and necessary gateways.
3. If information will not be available through integration, then the Contractor will include the cost to remove the existing controller hardware, replace with new ELC/SLC/ASC in accordance with part 2 of this specification. This includes all hardware/programming, wiring, testing and commissioning as noted in this specification.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. The Building Automation System (BAS) shall be designed, installed, and commissioned in a turnkey fully implemented and operational manner; including all labor not noted in the Description of Work and Additional Work paragraphs of Part I of this Specification, and not noted in other Sections of this Specification.

B. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

C. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability and compatibility and be executed in strict adherence to local codes and standard practices.

### 3.2 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Report any discrepancies, conflicts, or omissions to the Engineer for resolution before rough-in work is started.

B. The Contractor shall inspect the site to verify that equipment may be installed as shown. Report any discrepancies, conflicts, or omissions to the Engineer for resolution before rough-in work is started.

C. The Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate-or if any discrepancies occur between the plans and the Contractor's work and the plans and the work of others-the Contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the Contractor to report such discrepancies shall be made by-and at the expense of-this Contractor.

### 3.3 PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect any material that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

C. The Contractor is made aware through this specification that work will occur in existing building areas that will remain occupied. All work will proceed with full protection of existing spaces and with minimal disruption of building tenants and employees. The Contractor shall be liable for any damage caused by their installation. The building staff will be responsible for normal housekeeping.

D. Coordinate and schedule all work with the using agency's representatives. Provide a weekly schedule that notes the progress of the prior week, and projects the progress of the next three weeks to allow for the coordination of work areas and to give the management staff ample time to notify tenants and employees.

## 3.4 COORDINATION

A. Site

1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If the Contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the Contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
2. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals. Refer to Submittals in Part 1 of this specification for requirements.

## 3.5 FIELD QUALITY CONTROL

A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state and federal codes and ordinances as identified in Part 1 of this specification.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship, and shall submit method for performing this monitoring in accordance with Submittals as discussed in Part 1 of this specification.

C. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

## 3.6 WEB SERVER

A. Provide the following user interface equipment and devices in accordance with Part 2 of this specification:

1. One web server computer

## 3.7 OPERATOR INTERFACE

A. Provide the following user interface equipment and devices in accordance with Part 2 of this specification:

1. One desktop building workstation
2. One laptop workstation

B. The following graphic displays are required as a minimum.

1. Building riser and/or floor plan to select major equipment
2. Building floor plans that display all space temperature and allow the user to “click” on a temperature and view a detail graphic that shows each zone’s complete information
3. Schematic of each major HVAC system, heat pump water system, etc. including all setpoint changes and overrides
4. Historical display of trended data in both text based and graphical form
5. Alarm screen that allows acknowledgement
6. Schedule screens
7. Utility and energy management screen
8. Global command screen allowing all cooling valves to be opened or all heating valves to be opened.
9. Lighting control screens on a per building basis
10. Emergency notification screen

    a. Global and building-by-building fire alarm system screens
    b. Refrigerant, carbon monoxide, chlorine and NO2 sensor levels.

C. For parameters that are not adjustable via the graphical user interface, and which require the use of a software package other than a standard web browser, provide a help screen that is accessed from the graphic for the system explaining how to adjust the parameters, and where the software to allow this resides.

D. The following reports are required as a minimum. All reports are to be set up by the contractor installing the BAS and automatically downloaded with the frequency listed. As part of the training, demonstrate to the using agency the process of creating these reports.

1. Measurement and verification report on a monthly basis including the following:

    a. Utility and energy management information including measured data, input data and predicted data
    b. Equipment runtimes
    c. Average space temperature
    d. Average outside air temperature
    e. Heating degree days
    f. Wetbulb cooling degree days
    g. Scheduled hours of operation
    h. Disabled/overridden points
    i. Points out of range

2. Custom reports defined by the user – total of 2
3. Classroom Report on a weekly basis including the following:

    a. Classroom number
    b. Total monthly occupied hours
    c. Total monthly hours temperature within setpoint (including control accuracy as stated in Part 1 of this specification)
    d. Total times each classroom was out of setpoint (including control accuracy as stated in Part 1 of this specification)

4. Predictive maintenance alarm log on a monthly basis

E. Provide an alarm paging program that sends alarm to a user-defined pager, backup pager and standby pager as selected by the operator. Provide the list of alarms to be sent to the pager and the code for those alarms as part of the submittals as defined in Part 1 of this specification.

1. Provide the user with the ability to adjust which alarms get sent to the pager, and the message that accompanies those alarms, i.e., CRITICAL, NON-CRITICAL, etc.
2. Paging program shall be capable of alphanumeric, numeric or e-mail-based transmission, and the contractor will coordinate with the using agency to setup the system to match the using agency's present paging service. The contractor will then provide training for the using agency on how to adjust the program to changes in the paging service.

## 3.8 CONTROLLERS

A. All control associated with a single AHU, DX condensing units, or other system, shall be on a single controller. The exceptions to this are global points such as outside air temperature.

B. Provide the following spare point types and quantity on either an ELC or an SLC as follows.

1. Binary (Digital) output – 4 per mechanical room
2. Binary (Digital) input – 4 per mechanical room
3. Analog input – 2 per mechanical room
4. Analog output – 2 per mechanical room
5. It is the intent of this requirement that spare capacity be distributed in the same fashion as connected points installed under the contract. Providing all spare points in one or two locations, if there are 3 or more locations of distributed I/O will not be acceptable.

C. Provide a minimum number of ELCs for this project based on the following: one for each fan system (RTU / AHU / MAU), one for the boilers, one for the chillers, and a minimum of one for the terminal units / FCUs. If the capacity of ELC require more than the minimum, then provide as many as needed to satisfy the point requirements of this specification.

1. ELC shall be powered from circuits as shown on the electrical drawings. At least one ELC per building shall have a UPS that provides ½ hour operation of the processor components in the event of a power failure. This UPS does not have to power input/output devices under these conditions.
2. Power line filtering: Provide transient voltage and surge suppression for all workstations and controllers. If surge protection is not provided integral to the ELC, then the Contractor will provide any wiring or devices required to provide surge protection externally. Surge protection shall have the following as a minimum:

a. Dielectric strength of 1000 volts minimum
b. Response time of 10 nanoseconds or less
c. Transverse mode noise attenuation of 65dB or greater
d. Common mode noise attenuation of 150 dB or better at 40Hz to 100Hz

D. Power all temperature control panels from a dedicated power circuit.

1. Tag breaker in panels as "essential power, do not turn off". All wiring by the contractor installing the BAS.
2. If emergency power or a central building UPS is available in the building, then emergency power or central building UPS circuits shall be used to provide power for the entire building automation system including but not limited to the workstation, web server, primary ELC, and ELC/SLC/ASC, etc. Where electrical drawings show multiple panels powered from emergency panels / central building UPS panels, follow the requirements of the electrical drawings. When emergency power or power from a central building UPS is not available in the building, provide an Uninterruptable Power Supply (UPS) system or multiple UPS units for the entire building automation system.

## 3.9 CONTROL PANELS

A. Install control panels where shown and as indicated in documentation. Provide panels with hinged doors and NEMA classification appropriate for the application.

B. All power supplies, points and interface devices for a given system that are not located at or on the equipment to be controlled shall be contained within a single control panel.

C. Label all control panel devices and terminal strips in accordance with article Identification of Hardware and Wiring as discussed in Part 3 of this specification. Provide plastic, engraved labels on the panel cover identifying the system controlled and the node number of the system as a minimum. If any manual reset devices are located with a given control panel, a plastic, engraved label shall indicate the device is present within the panel.

D. Where sequences require audio or visual notification, the horn, strobe, or other similar device shall be mounted on the control panel and labeled with a plastic, engraved label indicating the equipment in alarm and whether the alarm is manual or automatic reset.

E. A copy of as-built information associated with the panel shall be included in the panel in a pocket or folder attached to the inside of the front cover of the panel.

F. Where existing panels are to be reused, replace any panel covers that have abandoned devices installed through the panel cover.

## 3.10 WIRING

A. All power wiring and control wiring shall be properly supported, and shall be run in approved raceway in a neat and workmanlike manner according to CCBC, Division 26 requirements, and the requirements of this specifications or BAS drawings. All wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All wiring pertaining to the BAS shall be color-coded or number coded and appropriately identified for servicing of the TC wiring system.

B. All wiring shall be within walls and above ceilings in public spaces. Where wiring in public/patient spaces cannot be hidden from view, use surface mounted raceway (must include pick proof sealant for safety. See 079200) with color selected by the Architect. In all other areas, wiring will be run in metal conduit. Conduit color shall be blue. See Division 26 for conduit specifications. In no case is wiring to be run exposed.

C. The Contractor shall be responsible for all electrical installation required for a fully functional system and not shown on the electrical plans or required by the electrical specifications. All wiring shall conform to all local and national codes. All electronic wiring shall be minimum #20 AWG minimum and shielded if required.

D. All low-voltage wiring shall meet CCBC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.

E. Install category 6 cable from each ELC panel to the server room.

F. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

G. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.

H. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

I. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Contractor shall provide step-down transformers.

J. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

K. Maintain fire rating at all penetrations.

L. Size of raceway and size and type of wire shall be the responsibility of the Contractor in keeping with the manufacturer's recommendations and CCBC requirements, except as noted elsewhere.

M. Include one pull string in each raceway 1 in. or larger.

N. Use coded conductors throughout with conductors of different colors.

O. Control and status relays are to be located in designated enclosures only. These enclosures include package equipment control panel enclosures unless they also contain Class 1 starters.

P. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 in. from high temperature equipment (e.g., steam pipes or flues).

Q. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

R. Adhere to applicable building code requirements where raceway crosses building expansion joints.

S. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

T. The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams at the job site with terminations identified.

U. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 ft. in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

V. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

W. Do not run temperature control wiring in conduits installed by other trades unless expressed permission is granted, in writing, by the Contractor and the Engineer.

## 3.11 COMMUNICATION WIRING

A. The Contractor shall adhere to the items listed in Wiring as discussed in Part 3 of this specification, including requirement that all wiring be run in color coated (blue) conduit.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

C. Do not install communication wiring in raceway and enclosures containing Class 1 wiring. The exceptions to this are control panels where the layout of the control panel shall be such that communication wiring does not have to cross any Class 1 wiring.

D. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable. Submit testing procedures in accordance with Submittals as discussed in Part 1 of this specification.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.

G. All runs of communication wiring shall be un-spliced length when that length is commercially available. All runs over commercially available lengths must be continued and connected in accordance with the manufacturer's requirements.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding or coaxial cable shall be in accordance with NEC regulation article on "Communications Circuits, Cable, and Protector Grounding."

J. Provide pick proof sealant (079200) where wire mold installations are provided in public / patient areas.

## 3.12 INSTALLATION OF SENSORS AND METERS

A. Install sensors and meters in accordance with manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors installed in new walls shall be installed on concealed junction boxes properly supported by the wall framing.

1. Sensors in general public spaces and classrooms will have stainless steel cover plate.
2. Sensors in corridors and other common areas shall have either stainless-steel cover plate or appropriately sized plastic or metal wire, locking guard.
3. Sensors in animal spaces will have stainless steel cover plate or stainless-steel animal resistant locking guard.
4. Sensors in back of house areas will have stainless steel cover plate or appropriately sized plastic or metal wire locking guard.
5. Sensors in offices, conference rooms and meeting rooms shall have visual display with local setpoint adjustment (adjustment range initial set thru the BAS at +/- 3F of local adjustability).
6. Coordinate initial setpoints with using agency.
7. Sensors in gymnasiums, cafeterias, corridors and other common areas shall have either stainless-steel cover plate or appropriately sized plastic or metal wire, locking guard.
8. Locate sensor such that computers, water coolers, and other heat generating equipment are not operating near the sensor.
9. For sensors installed inside walls, provide insulation in the box that seals the sensor from the conduit connected to the box.

D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Averaging sensors and low-limit switches

1. Sensors used in mixing plenums, hot and cold decks, energy recovery applications or ducts over 48" any direction shall be of the averaging type.
2. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
3. Low limit sensors shall be mounted in a serpentine manner, horizontally across duct in accordance with manufacturers recommended installation procedures.
4. Provide 1 ft of sensing element for each 1 $ft^2$ of coil area.
5. For large duct areas where the sensing element does not provide full coverage of the air stream, additional sensors or switches shall be provided as required to provide full protection of the air stream.
6. Wire one pole of the low-limit switch to the supply and return fan starters, one pole to a BAS input, and one pole to interrupt power to the associated unit heating valves and economizer dampers.

F. All pipe-mounted temperature sensors shall be installed in wells. Use conductive compound in all wells to provide good heat transfer.

G. Install aspirated enclosure containing outdoor air temperature, carbon dioxide sensor and humidity sensors on north wall at designated locations. They shall be located so as to avoid effects of sun, reflected sun, exhaust air, radiant heat from building materials, etc. Location to be approved by Engineer.

H. Carbon Dioxide / Carbon Monoxide / Nitrogen Dioxide / Refrigerant Sensors and Light Level Switches.

1. Where sensing and/or switches are used in the sequence of operation or shown on documents, provide sufficient quantity of sensors / switches for full coverage of zone as recommended by the manufacturer considering space layout / height and obstructions within the HVAC zone.
2. Mounting heights as recommended by the manufacturer for the application.
3. Coordinate all locations with architect. Color by architect.
4. Install per manufacturers requirements / recommendations and local code.
5. Wall sensors/switches shall be concealed in junction boxes properly supported from wall frame.
6. Carbon monoxide sensors shall be connected to both the building automation system and the fire alarm system.

I. HVAC zone occupancy sensors.

1. Where occupancy sensing is used in the sequence of operation or shown on documents, provide sufficient quantity and types (wall and ceiling) of sensors for full coverage of zone considering space layout / height and obstructions within the HVAC zone.
2. Coordinate all locations with architect.
3. Install per manufacturers requirements / recommendations and local code.
4. Wall sensors shall be concealed in junction boxes properly supported from wall frame.
5. Ceiling sensors shall be concealed in junction boxes properly supported from structure above.
6. Where occupancy sensors are provided by the lighting control system, the sensor layout matches the HVAC zone and occupancy status of the zone sensors is available to the building automation system and monitored by the building automation system through a BACnet interface, the lighting control system occupancy sensors may be used in place of or in combination with the HVAC zone occupancy sensors. Coordinate with the lighting control system. Provide all hardware/software/programming/wiring as required to interface with the lighting control system.

J. Pressure sensors and switches.

1. Provide accessories as required to dampen input signal to transducers and reduce fluctuations in the signal.
2. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
3. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

4. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

K. Low-limit sensors and other safeties shall have at least two poles; one hard wired to fan starter, and one wired to BAS. Low limit sensors will have an additional pole to interrupt power to the associated unit heating valves and economizer dampers.

L. For water level switches, if a separate manufacturer's panel is not provided, then provide a separate panel including all power sources, relays to provide alarm notification as well as BAS input notification, alarm bell, silence switch, and panel labeling as noted in this specification.

M. Damper end-switches for combustion air applications will be mounted directly to the damper blade. Switches integral to the actuator, or that monitor only the actuator position will not be acceptable.

N. Smoke detectors are to be installed with sampling tube, and in a section of ductwork as noted by the manufacturer. One N.C. contact will be wired to shut down the supply and return/relief fans; the second shall be N.O. and provide an input to the BAS and a third shall be wired to the fire alarm system. Wiring to the fire alarm system by fire alarm provider.

O. Coordinate location/orientation of all meters and associated sensors / displays in the field with meter manufacturer's factory representative for compliance with installation requirements, accessibility and maintenance.

P. Provide overflow switches / moisture detectors in fan coil unit auxiliary drain pans. Wire units to shut down the fan coil upon overflow / detection of water.

## 3.13 INSTALLATION OF ACTUATORS

A. Mount and link control damper actuators according to the manufacturer's instructions.

1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5º open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide all mounting hardware and linkages for actuator installation.

B. Electric/Electronic

1. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
2. Valves: Actuators shall be connected to valves by the manufacturer. New valves that require field mounting of actuator will not be accepted. Valves schedule designates the control panel to which the valve actuator is to be terminated.

## 3.14 INTEGRATION WITH THIRD-PARTYMANUFACTURER'S EQUIPMENT

A. Provide communication interfaces to the following in accordance with Part 2 of this specification:

1. Variable frequency drives.
2. Chillers
3. Switchboard meter
4. Lighting control system
5. Fire alarm system
6. Boilers
7. Humidifiers
8. Electrical distribution systems controller
9. Paint booth ventilation system
10. Variable refrigerant flow systems
11. RTUs / AHUs / MAUs
12. Condensate / feedwater pump control panels
13. Flow meters / BTU meters / utility meters (water / gas / electric).
14. Electrochromic glass
15. Ductless split systems / computer room conditioning units.
16. Generator.
17. Automatic transfer switch.
18. Switchgear.
19. Laundry exhaust systems.
20. Water heaters
21. Snowmelt / radiant heating system
22. Domestic Booster Pumps.
23. Kitchen Exhaust Hoods.

B. Provide hardwire interfaces to the following:

1. Sump pump control panel
2. Ejector pump control panel
3. Fire alarm to destratification fan control panel.
4. Pulse meters / sub-meters.
5. Water heaters
6. Domestic Booster Pumps
7. Electric Meters.
8. Kitchen Exhaust Hoods
9. Snowmelt / radiant heating system.

## 3.15 WARNING LABELS

A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows:

C A U T I O N
This equipment is operating under automatic control
and may start or stop at any time without warning.
Switch disconnect to “Off” position before servicing.

B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows:

C A U T I O N
This equipment is fed from more than one
power source with separate disconnects
Disconnect all power sources before servicing.

## 3.16 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.

B. Permanently label or code each point of field terminal strips to show the instrument or item serviced.

C. Identify control panels with minimum 1 cm (1/2 in.) letters on engraved plastic nameplates. Nameplate shall include systems controlled and node number of controller contained within the panel.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors relating to the terminal box or valves with nameplates. For stainless steel cover plate sensors, identifier shall be on inside of plate.

F. Manufacturer's nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

## 3.17 START-UP AND COMMISSIONING

A. The Contractor shall completely check out, calibrate and test all connected hardware and software to ensure that the system performs in accordance with the approved specifications and Sequences of Operation submitted. This work shall be completed prior to notifying the Engineer that the system is ready for acceptance.

B. The Contractor is to take primary responsibility of start-up of all equipment and coordinate with other contractors and equipment manufacturers as necessary. The Contractor shall provide all labor and necessary test apparatus required to calibrate and prepare for service all of the instruments, controls and accessory equipment furnished under this specification.

C. The contractor installing the BAS shall test all control wiring and devices prior to start-up. This includes verifying that all wiring is properly connected and free of all shorts and ground faults. Verify that all connections are tightened appropriately. Calibrate each device as required by the manufacturer's recommendations.

D. Verify the binary output devices operate properly and that the normal positions are correct.

E. Verify that all analog output devices are functional, that start point and span are correct, and that direction and normal positions are correct including fail-safe positions. The Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The Contractor shall make any necessary adjustments to valve stem and damper blade travel.

F. Complete software shall be installed and tested (dry run) prior to start-up.

G. Coordination with Test and Balance:

1. Provide training for the Test and Balance contractor on the tools needed to balance all equipment.
2. Provide software and field labor to correct BAS errors found during balancing.

H. Software technician shall be on premise for all cut-overs, and remain "on call" for following 48 hours after any start-up. If called after normal hours, must respond within 4 hours, the premium portion only, of any call may be billed to using agency.

I. Software technician shall observe and fine tune all control loops.

J. Alarms and interlocks:

1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

K. Return the system to a normal operating state after each phase of start-up, commissioning and demonstration. Any points overridden, devices place in manual position, setpoints adjusted, etc. are to be restored to normal operating condition prior to acceptance.

## 3.18 DEMONSTRATION AND ACCEPTANCE

A. Demonstration

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests in accordance with the Start-Up and Commissioning portion of part 3 of this specification.
2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the Start-Up and Commissioning portion of part 3 of this specification. The Engineer will be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in the Submittals section of part 1 of this specification. The approved checklists and forms shall be completed for all systems as part of the demonstration.

4. The Contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fore/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with System Performance section of part 1 of this specification.
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:

    a. DDC loop response. The Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over –damped control shall require further tuning by the Contractor.
    b. Optimum start/stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
    c. Interface to the building fire alarm system
    d. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the Engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Contractor shall be responsible for the hardware and software necessary to complete all tests.
11. If, during any of the demonstration process, the contractor is required to make corrections a total of three times, the Engineer can cancel the demonstration. The session will then be rescheduled, and the contractor will perform the demonstration again at their own cost. Continued occurrences will result in the contractor compensating the Engineer for visits during which the system was not ready for demonstration.

B. Acceptance

1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and the using agency prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if state as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in the Submittals section of Part 1 of this specification.

C. Specification Punch List Review: The Engineer shall perform no more than two punch list reviews of the system to verify compliance with these specifications. Should the system not be acceptable as complete after the second review, the BAS Contractor shall agree to pay all additional expenses incurred by the Engineer in verifying system compliance at the Engineer's current standard rate.

D. Contractor shall remove and replace, at their expense, all items which are not in compliance with the specification requirements.

## 3.19 CLEANING

A. The Contractor shall clean up all debris resulting from his/her activities daily. The Contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the Contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material repainted to match the adjacent areas.

## 3.20 TRAINING

A. Provide a minimum of four on-site or classroom training sessions throughout the contract period for personnel designated by the using agency. The first two sessions shall be eight (8) hours each and shall take place when work commences, and when the project is half-way completed. The third session shall be sixteen (16) hours in duration, and shall take place one week prior to the system demonstration detailed in Demonstration and Acceptance of part 3 of this specification. The final session shall be twenty-four (24) in duration and will take place after acceptance. At no time will an individual session be of greater than four (4) hours duration.

B. The last training session will include professional videotaping of no more than two hours of basic system operation as demonstrated throughout the previous training. Generate a list of items to be included in the taped session and review with the Using agency and CA prior to taping. The contractor will be responsible to ensure that the setup of the facilities and location of cameras will provide adequate representation of the system operation. Provide a list of items covered including a time chart noting where on the tape the items occur.

C. Provide two additional four-hour training sessions at each of 6 and 12 months following the system acceptance and building turnover (total of 16 hours). Each session must be coordinated with the building using agency.

D. Train the designated staff of using agency's representative and using agency to enable them to do the following:

E. Day-to-day Operators:

1. Proficiently operate the system
2. Understand control system architecture and configuration

3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate the workstation and peripherals
6. Log on and off the system
7. Access graphics, point reports, and logs
8. Adjust and change system setpoint, time schedules, and holiday schedules
9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
10. Understand system drawings and Operation and Maintenance Manuals
11. Understand the job layout and location of control components
12. Access data from DDC controllers and application specific controllers.
13. Operate portable operator terminals

F. Advanced Operators:

1. Make and change graphics on the workstation
2. Create, delete, and modify alarms, including annunciation and routing of these
3. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable intervals
4. Create, delete, and modify reports
5. Add, remove, and modify system's physical points
6. Create, modify, and delete programming
7. Add panels when required
8. Add operator interface stations
9. Create, delete, and modify system displays both graphical and others
10. Perform DDC system field checkout procedures
11. Perform DDC controller unit operation and maintenance procedures
12. Perform workstation and peripheral operation and maintenance procedures
13. Perform DDC diagnostic procedures
14. Configure hardware including PC boards, switches, communication, and I/O points
15. Maintain, calibrate, troubleshoot, diagnose and repair hardware
16. Adjust, calibrate, and replace system components

G. System Mangers/Administrators:

1. Maintain software and prepare backups
2. Interface with job-specific, third-party operator software
3. Add new users and understand password procedures

H. These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.

1. Day-to-day Operators: parts 1-13
2. Advanced Operators: parts 1-29
3. System Managers/Administrators: parts 1-13 and 30-32

I. Provide course outline and materials in accordance with the Submittals section of part 1 of this specification. The instructor(s) shall provide one copy of training manual per student.

J. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

K. Classroom training (limited to the first two sessions) shall be done using a network of working controllers' representative of the installed hardware. Training just prior to and after the demonstration of the system shall take place on the installed system hardware and software components.

L. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary, and the demonstration repeated. If during the training session, the trainer debugs the system more than three (3) times, or for an amount of time more than 30 minutes, the training session will be immediately terminated and rescheduled for its full duration.

## PART 4 - SEQUENCE OF OPERATION

### 4.1 SCOPE OF WORK

A. Provide fully implemented application and custom software and controls necessary to accomplish the control sequences as follows in this part of the specification.

1. The temperature control system continuously monitors both outdoor and indoor conditions. It operates the HVAC equipment for the building and sends alarms to a local workstation.
2. This sequence of operation may require minor changes or fine-tuning in the field to achieve the using agency's exact operational requirements. This Contractor will be responsible to coordinate with the using agency and make any necessary software adjustments to achieve the intended results.

B. The following sequences are designed to describe the scope of control required. The Contractor is responsible to expand these sequences in complete detail, describing all modes of operation, including, alarm conditions, failure modes, start-up, shut-down, etc. Submitted sequences are expected to be detailed, showing algorithms and all "decision trees".

C. Points listed in the design documents are the minimum required. The contractor is responsible to meet the sequence of operations and provide all points (hardware and software) that are required to meet the sequences of operation. Where the sequence and point list conflict, the more stringent requirement will apply.

D. Temperature control contractor to include 40 hours to meet with the engineer of record prior to shop drawing submission to further develop/expand the sequences for a complete and fully functional system.

### 4.2 GENERAL SEQUENCES

A. The following sequences apply to each piece of equipment where applicable. When they are referenced in a specific sequence by name, they are considered to be there, included in their entirety. Note: All setpoints shown are to be operator adjustable, from a graphic screen.

B. Provide all necessary hardware, components, software, programming and wiring to supplement that provided by the equipment manufacturers and implement the sequence of operations. Control system / operation shall be a fully functional code / energy code compliant system.

C. Economizer Flag:

1. The economizer flag shall be set by one of the Enterprise Level Controllers. The economizer flag will be broadcast to all controllers that require it.
2. The flag will be ON if ANY of the following conditions are true:

    a. The OA-DB temperature is less than 50°F (at any OA-RH level)
    b. The OA-DB is less than 52°F (when OA-RH is less than 85%)
    c. The OA-DB is less than 54°F (when OA-RH is less than 70%)
    d. The OA-DB is less than 56°F (when OA-RH is less than 60%)
    e. The OA-DB is less than 58°F (when OA-RH is less than 50%)
    f. The OA-DB is less than 60°F (when OA-RH is less than 40%)
    g. The OA-DB is less than 62°F (when OA-RH is less than 30%)
    h. The OA-DB is less than 64°F (when OA-RH is less than 20%)
    i. The OA-DB is less than 66°F (when OA-RH is less than 10%)

3. For the sequence above, the economizer flag will reset to OFF when the OA-DB exceeds setpoint by 2°F at the given OA-RH. For example, if the OA-RH is 45%, the economizer flag will be set to ON when the OA-DB drops below 58.0°F, and the flag will reset to OFF when the OA-DB exceeds 60.0°F.
4. For sequences that call for comparative enthalpy control, the DDC shall compare the OA enthalpy to the RA enthalpy. The economizer flag will be ON when the RA enthalpy exceeds the OA enthalpy by 1.5 BTU/lb. of dry air.

D. Optimized Start: The optimized start program will monitor OA temperature and space temperature and calculate the desired startup time.

1. Formulae:

    a. OAΔT = OAT minus 65 (in Winter Mode)
    b. OAΔT = OAT minus 75 (in Summer Mode)
    c. SpaceΔT = Space Temp minus heating setpoint (in Winter Mode)
    d. SpaceΔT = Space Temp minus cooling setpoint (in Summer Mode)
    e. Start-up Time = OAΔT*K1 + SpaceΔT *K2; where K1 and K2 are self-adaptive constants.

2. Morning Cool Down:

    a. When the average of the space temperatures is above 78°F (adjustable from 72°F to 84°F), an optimum morning cooldown will occur for that scheduling zone.
    b. The optimum start program attempts to bring the average space temperature to within 1°F (adjustable) of the average space temperature setpoint at the exact time of scheduled occupancy. The maximum cooldown period will be limited to 4 hours (adjustable). The BAS will estimate the time needed to reach the average space temperature and start the fan.
    c. Note: Make-Up air units without recirculation and dedicated OA air handling units with energy recovery shall not be used for morning cool down unless OA conditions meet Economizer Flag ON conditions listed above. When make-up air

units without recirculation are used for morning cool down, enable associated exhaust fan. Spaces served by these units will utilize the space fan coil units for morning cool down when OA economizer conditions are not met.

3. Morning Warm Up:

   a. When the average of the space temperatures is below 68°F (adjustable from 60°-72°), an optimum morning warm-up will occur. Morning warm-up is the same as morning cooldown except for the following changes:
   b. The maximum warm-up period will be 3 hours (adjustable).
   c. A separate set of K values will be used for morning warm up.
   d. During optimum start, the AHU supply fan and return (if provided) fans shall operate. On VAV systems, VAV boxes shall be full open. Heating coils shall be in full heat.
   e. The OA dampers will remain closed.
   f. Morning warm-up will end when average RA temperature for the system rises above 72°F (adjustable from 70°F-74°F).
   g. Make-Up air units without recirculation and dedicated OA air handling units with energy recovery shall not be used for morning warm up. Spaces served by these units will utilize the space fan coil units, fin tube and infrared heaters.

E. Unoccupied Control Modes:

1. During unoccupied schedule times, equipment may be enabled to perform night setback, night setup, or night purge.
2. Night Setback Mode:

   a. During night setback, the system will track the space temperature, comparing its value with the adjustable night setback setpoint.
   b. Setback will occur on a room-by-room basis.
   c. The system will run with maximum heat until the space temperature rises above the setback setpoint by 3°F (adjustable).
   d. Make-Up air units without recirculation and dedicated OA air handling units with energy recovery shall not be used during night setback.

3. Night Setup Mode:

   a. During night setup mode, the system will track the space temperature, comparing its value with the adjustable night setup setpoint.
   b. Setup will occur on a room-by-room basis.
   c. The system will run with maximum cooling until the temperature drops below the setup setpoint by a pre-determined amount.
   d. Make-Up air units without recirculation and dedicated outside air handling units with energy recovery shall not be used during night setback.

4. Night Purge Mode:

   a. During unoccupied times, if the economizer flag is ON, and the highest space temperature rises above the setup setpoint, the system will enter night purge mode.
   b. The system will continue to run until the highest space temperature drops below the setup setpoint by a pre-determined amount, or the economizer flag goes off.

c. Make-Up air units w/ associated return/exhaust fans and dedicated outside air handling units with energy recovery shall be employed in night purge mode.

5. Setback and setup cannot occur during the same unoccupied period. Setup can only happen if night purge cannot.

F. Summer/Winter Operation:

1. Systems will switch seasonal mode based upon an adjustable outside air temperature setpoint. Systems will not be able to switch from one mode to another unless the OA temperature passes the setpoint by a pre-determined value for a set amount of time.

G. Time of Day Scheduling:

1. Equipment that runs based on time-of-day schedule will have two, user definable schedules per day for each day of the week.
2. The scheduling should allow for holidays and at least ten special-event schedules for each piece of equipment.
3. The operator will have the ability to designate the last 0-2 hours of any occupied period as a coast time during which all space setpoints will be increased (or decreased based upon the season) by a single, user-definable amount.

H. Status Alarming and Run Time Monitoring:

1. All equipment that have status points will generate an alarm whenever the active state differs from the desired state (after a reasonable time delay to avoid nuisance alarms).
2. All equipment that have status points shall track run times based upon the equipment status. For items that have amp draw monitoring, the runtime will also track the level of loading of the equipment.

I. Lead/Lag Control and Run Time Monitoring:

1. Where equipment is staged in lead/lag fashion, the equipment shall have LEAD, LAG1, LAG2, etc. designations clearly depicted on the BAS workstation.
2. The overall run times of the equipment shall be clearly depicted on the BAS workstation.
3. Lead/Lag designations shall switch once per week based on overall run times. The equipment with the lowest overall run time will be
4. Even Wear - Where equipment is staged in lead/lag fashion, the piece of equipment with the lowest run time will start first. If status indicates that the piece of equipment is OFF, then generate an alarm and start the piece of equipment with the next least run time. Continue this staging as noted in the specific sequence of operation. When disabling lead/lag equipment, the equipment that first came on will be the first equipment to be disabled.
5. Uneven Wear – Where equipment is staged in lead/lag fashion, rotate the lead piece of equipment such that one piece will have a significantly larger runtime than other pieces. (e.g., in the case of 2 pieces of equipment operating in lead/lag fashion, one piece will run 2/3 of the time and the other 1/3 of the time)

4.3 SCHEDULES

A. Provide building schedules that can be assigned to program areas by the operations staff. A program area will refer to one type of building function (for example, theater-auditorium). The program area schedule shall be both a 365-day programmable and a 7-day weekly schedule. The operator will select, through the user-interface, which type of schedule they will use for each program area.

B. Provide all programming and configuration necessary for the operator to assign equipment to the program areas to which the equipment is associated. Note that one piece of equipment may serve more than one program area.

C. Provide a holiday schedule for each building, with at least 25 assignable holidays.

D. Provide three special event schedules for each building, as well as three for the campus as a whole.

E. The priority of schedule will be as follows:

1. Building special event schedule
2. Campus special event schedule
3. Holiday schedule
4. Program area schedule

## 4.4 CUSTOM PROJECT SEQUENCES

A. See drawings for project sequences.

**END OF SECTION**

**SECTION 23 11 23**

**NATURAL-GAS PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 22, 23 and 26 apply to this section.

### 1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Concrete bases.

### 1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

### 1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 5 psig.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.

B. Shop Drawings (Shop drawings shall be approved prior to installation of any products or components): For facility natural-gas piping layout fabrication drawings. Include plans, piping layout and elevations, connections to equipment, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops. All piping/accessories 4 inch diameter and larger shall be drawn double line. Shop drawing shall be created in AutoCAD latest edition. Copies of design drawings are not acceptable.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

C. Record Drawings: For facility shop drawings corrected for actual installation showing natural-gas piping layout. Include plans, piping layout and elevations, connections to equipment, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops. All piping/accessories 4 inch diameter and larger shall be drawn double line. Shop drawing shall be created in AutoCAD latest edition. Copies of design drawings are not acceptable. Provide both paper copy (five full size) and electronic AutoCAD files.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

D. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

E. Operation and Maintenance Data: Motorized valves, regulators and field quality-control reports.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids (Projects with existing natural gas systems): Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Architect / Owner no fewer than five days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Architect's / Owner's written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 8 Section "Access Doors and Frames."

**PART 2 - PRODUCTS**

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B. (ABOVE GROUND APPLICATIONS ONLY)

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel.

5. Mechanical Couplings:

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        1) Dresser Piping Specialties; Division of Dresser, Inc.
        2) Smith-Blair, Inc.

    b. Stainless-steel flanges and tube with epoxy finish.
    c. Buna-nitrile seals.
    d. Stainless-steel bolts, washers, and nuts.
    e. Coupling shall be capable of joining steel pipe to PE pipe, or steel pipe to steel pipe.

B. PE Pipe: ASTM D 2513, SDR 11 (UNDERGROUND PIPING ONLY).

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.

c. Aboveground Portion: PE transition fitting.
d. Outlet shall be threaded or flanged or suitable for welded connection.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves in locations accessible to the public..
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
7. Above ground applications only.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in locations accessible to the public.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
5. Above ground applications only.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.; Apollo Div.
    b. Lyall, R. W. & Company, Inc.
    c. McDonald, A. Y. Mfg. Co.
    d. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
11. Above ground applications only.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
9. Above ground applications only.

E. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. McDonald, A. Y. Mfg. Co.
    b. Mueller Co.; Gas Products Div.
    c. Xomox Corporation; a Crane company.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
11. Above ground applications only.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Flowserve.
    b. McDonald, A. Y. Mfg. Co.
    c. Milliken Valve Company.
    d. Mueller Co.; Gas Products Div.
    e. R&M Energy Systems, A Unit of Robbins & Myers, Inc.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
11. Above ground applications only.

G. PE Ball Valves: Comply with ASME B16.40 (UNDERGROUND PIPING APPLICATIONS).

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Kerotest Manufacturing Corp.
   b. Lyall, R. W. & Company, Inc.
   c. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves.

H. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

## 2.5 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ASCO Power Technologies, LP; Division of Emerson.
   b. Eaton Corporation; Controls Div.
   c. Eclipse Combustion, Inc.
   d. Honeywell International Inc.

e. Johnson Controls.

2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. Normally closed.
6. Visual position indicator.
7. [Electrical] [Mechanical] operator for actuation by appliance automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ASCO Power Technologies, LP; Division of Emerson.
b. Eclipse Combustion, Inc.
c. Magnatrol Valve Corporation.
d. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

## 2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Actaris.
b. American Meter Company.
c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
d. Invensys.

e. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Actaris.
b. American Meter Company.
c. Eclipse Combustion, Inc.
d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
e. Invensys.
f. Maxitrol Company.
g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Canadian Meter Company Inc.
    b. Eaton Corporation; Controls Div.
    c. Harper Wyman Co.
    d. Maxitrol Company.
    e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig.

## 2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: No preference
2. Description:

    a. Standard: ASSE 1079.
    b. Pressure Rating: 125 psig minimum at 180 deg F.
    c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: No preference.
2. Description:

    a. Standard: ASSE 1079.
    b. Factory-fabricated, bolted, companion-flange assembly.
    c. Pressure Rating: 125 psig minimum at 180 deg F.
    d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: No preference
2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape and Tracer Wire: Non-biodegradable, acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, yellow in color laid at a depth of 12 inches in piping ditch prior to backfilling. Provide tracer wire alongside the entire length of pipe, up to and including a point 12 inches above grade on the outside riser. Tracer wire shall be at a minimum of AWG 14 insulated corrosion protected copper wire, detectable by metal detector when buried up to 30 inches deep.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Renovations & Additions: Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the local utility and the International Fuel Gas Code for installation and purging of natural-gas piping. Where differences occur, comply with the local utility requirements.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating (ABOVE GROUND APPLICATIONS):

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

F. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

## 3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap. Maintain a minimum of 15 feet separation from all building openings (louvers, flues, vents, operable windows, doors, etc.).

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

Z. Provide flexible connections in piping at all building expansion joints. See architectural drawings for building expansion joint locations.

AA. Install natural gas meters furnished under 230900 per manufacturer's requirements. Coordinate in the field final location/orientation of meter and displays with meter manufacturer's representative for compliance with installation requirements, accessibility and maintenance.

## 3.5 VALVE INSTALLATION

A. Install underground valves with valve boxes.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C. Install earthquake valves aboveground outside buildings according to listing.

D. Install anode for metallic valves in underground PE piping.

## 3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.

4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

## 3.7 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

## 3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions or as indicated on drawings/details whichever is more stringent. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Install tracer wire alongside the entire length of pipe up to and including a point 12 inches above grade on the outside riser.

3.10 PAINTING

A. Comply with more stringent requirements between Division 9 painting Sections andthat listed below for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel semigloss.
d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters andmeter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex over Alkyd Primer System: MPI INT 5.1Q.

a. Prime Coat: Alkyd anticorrosive or Quick-drying alkyd metal primer.
b. Topcoat: Interior latex semigloss.
c. Color: Yellow.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.14 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be:

1. PE pipe and fittings joined by heat fusion, service-line risers with tracer wire terminated in an accessible location.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints (2” and smaller pipe).
2. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints (2” and smaller pipe).

2. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. PE pipe, riser and fittings joined by heat fusion, with tracer wire terminated in an accessible location. Piping shall be in containment conduit vented to outdoors.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints (2” and smaller pipe).
2. Steel pipe with steel welding fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. PE pipe, riser and fittings joined by heat fusion, with tracer wire terminated in an accessible location. Piping shall be in containment conduit vented to outdoors.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.17 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground:

1. PE valves.
2. NPS 2 and Smaller: Bronze plug valves.
3. NPS 2-1/2 and Larger: Cast-iron, lubricated or nonlubricated plug valves.

3.18 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, non-lubricated or lubricated plug valve.

C. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

**END OF SECTION**

**SECTION 23 21 13**

**HYDRONIC PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 23 and 26 apply to this section.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Makeup-water piping.
3. Condensate-drain piping.
4. Blowdown-drain piping.
5. Airvent piping.
6. Safety-valve-inlet and -outlet piping.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.4 SUBMITTALS: Submit one comprehensive hydronic piping submittal including parts A, & B below as well as valves from spec 230523. Submit 1.4 C & D with close-out documents. Indicate condensate drain pipe and pumped condensate pipe with VRV system per spec 235701.

A. Product Data: For each type of the following:

1. Pressure-seal fittings.
2. Valves. Include assemblies, flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
3. Air control devices.
4. Chemical treatment.
5. Hydronic specialties.
6. Differential pressure meter.
7. Glycol test kit.

B. Shop Drawings (Shop drawings shall be approved prior to installation of any products or components): Detail, at 1/4 scale, piping layout fabrication drawings, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of equipment, anchors, alignment guides, and expansion joints and loops. All piping/accessories 4 inch diameter and larger shall be drawn double line. Shop drawing shall be created in AutoCAD latest edition. Copies of design drawings are not acceptable.

C. Record Drawings: Detail, at 1/4 scale shop drawings corrected for actual installation showing piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of equipment, anchors, alignment guides, and expansion joints and loops. All piping/accessories 4 inch diameter and larger shall be drawn double line. Shop drawing shall be created in AutoCAD latest edition. Copies of design drawings are not acceptable. Provide PDF of plans, paper copy (five full size) and electronic AutoCAD files.

D. Operation and Maintenance Data: For air control devices, hydronic specialties, special-duty valves, chemical treatment, meters, test kits, field quality control test reports (see Part 3) and operation / maintenance manuals.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

## 1.6 DELIVERY, STORAGE AND HANDLING

A. Follow manufacturer’s recommendations for handling, unloading and storage.

B. Storage: Store per manufacturer's written recommendations. Store indoors in a warm, clean, dry place where pipe will be protected from weather, construction traffic, dirt, dust, water and moisture.

1.7 EXTRA MATERIALS

A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

C. Glycol test kit: For each type of glycol used in systems provide probes, hoses, sampling unit, percent by volume charts and carrying case.

1.8 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 150 psig at 250 deg F.
2. Makeup-Water Piping: 80 psig at 100 deg F.
3. Air Conditioning Condensate-Drain Piping: 100 deg F
4. Blowdown-Drain Piping: 200 deg F.
5. Air-Vent Piping: 200 deg F.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.9 WARRANTY

A. Written manufacturers' warranty covering parts and labor for a period of one year from substantial completion, or eighteen months from shipment, whichever is longer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Wrought Copper Tube and Fittings:

a. No preference.

2. Copper or Bronze Pressure-Seal Fittings:

a. Stadler-Viega.

b. Nibco

3. Dielectric Unions:

   a. No preference

4. Dielectric Flanges:

   a. No preference

5. Dielectric Flange Kits:

   a. No preference.

6. Dielectric Couplings:

   a. No preference.

7. Dielectric Nipples:

   a. No preference.

8. Bronze, Calibrated-Orifice, Balancing Valves:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.
   d. Griswold Controls.
   e. Nexus
   f. Taco.

9. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Flow Design Inc.
   d. Griswold Controls.
   e. Nexus.
   f. Taco.
   g. Hayes

10. Diaphragm-Operated, Pressure-Reducing Valves:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump; a division of ITT Industries.
    d. Spence Engineering Company, Inc.
    e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

11. Diaphragm-Operated Safety Valves:

    a. Amtrol, Inc.

b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Spence Engineering Company, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

12. Manual Air Vents:

a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Taco.
d. Approved Equal.

13. Automatic Air Vents:

a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Taco.
d. Approved Equal.

14. Pressure Fill System:

a. Armstrong.
b. Bell and Gossett.
c. Taco.

15. Bladder-Type Expansion Tanks:

a. Amtrol
b. Armstrong.
c. Bell and Gossett.
d. Taco.
e. Wessels

16. Tangential-Type Air Separator:

a. Armstrong.
b. Bell and Gossett.
c. Taco.
d. Spirotherm.

17. Y-Pattern Strainers:

a. Mueller Steam Specialties.
b. Piping Specialties Inc.
c. Spencer.
d. Nibco.

18. Stainless Steel Bellow, Flexible Connectors:

a. Mason.
b. Metraflex
c. Hyspan

19. Combination Hydronic Units:

    a. Flow Design Inc.
    b. Griswold Controls.
    c. Nexus
    d. Bell and Gossett
    e. Armstrong
    f. TA
    g. Taco

## 2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K (below ground installations).

C. Wrought-Copper Fittings: ASME B16.22.

D. Copper or Bronze Pressure-Seal Fittings:

1. Housing: Copper.
2. O-Rings and Pipe Stops: EPDM.
3. Tools: Manufacturer's special tools.
4. Minimum 200-psig working-pressure rating at 250 deg F.

E. Wrought-Copper Unions: ASME B16.22.

## 2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Class 125 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Class 150 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

I. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anvil International, Inc.
   b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
   c. National Fittings, Inc.
   d. S. P. Fittings; a division of Star Pipe Products.
   e. Victaulic Company.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings. Fittings shall not be used in place of or as flexible connections.
3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

## 2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

1. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

1. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

1. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F.

G. Dielectric Nipples:

1. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

## 2.6 VALVES

A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "Valves."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 control specification sections.

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.

3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Stem Seals: EPDM O-rings.
4. Disc: Glass and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved (where grooved piping is permitted).
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Low inlet-pressure check valve.
7. Inlet Strainer: stainless steel, removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Wetted, Internal Work Parts: Brass and rubber.
7. Inlet Strainer: stainless steel, removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

## 2.7 AIR CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 .
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

## 2.8 CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction, 125-psig working pressure, 5-gal. capacity, with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

B. Pressure Fill System: Provide a complete factory packaged automatic glycol / make-up water fill system unit per system as manufactured by Bell & Gossett (GMU) or equal by Taco, Armstrong as scheduled. The unit shall consist of a base, 55 gallon tank (steel or polyethylene) with removable lid, fill vent opening, observable fluid level indicator scale (gallons), Y-strainers, isolation valves, triple combination shut off – Non slam check – calibrated balance valves, open drip proof motor, pump, expansion tank, motor contactor, pressure controls, interconnecting piping, low level safety shut down, remote alarm contacts, indicator light, fill valve (automatic for water systems, manual for glycol systems), discharge pressure gauge, discharge line pressure reducing valve, isolation valves, pressure gauge and single point power connection.

C. Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

1. All new systems shall be compatible with 30% P.G. Solution. Glycol shall be added in future project when chiller is added.

## 2.9 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. Blow off ball valve with hose end and cap.
5. CWP Rating: 125 psig.
6. Integral pressure and temperature taps upstream and downstream (strainer sizes 2-1/2 inch and larger).

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

C. Combination Hydronic Units:

1. Hydronic units which combine multiple component functions into one (isolation valve, y-strainer, calibrated balance valve, air vent, union and P&T taps) may be used to minimize space and labor provided all functionality of the combined unit is equal to the individual components and all maintenance can be performed without draining down additional parts of the system. Combination units shall meet/better all material/rating/performance requirements of individual parts specified in Part 2.

**PART 3 - EXECUTION**

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2-1/2" and smaller, shall be:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

B. Hot-water heating piping, aboveground, NPS 3 to 4", shall be:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Grooved mechanical joint couplings and fittings may be used in exposed locations (not allowed above ceilings, in shafts or soffits).

C. Hot-water heating piping, aboveground, NPS 5" and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Grooved mechanical joint couplings and fittings may be used in exposed locations (not allowed above ceilings, in shafts or soffits).

D. Hot-water heating piping installed belowground and within slabs shall be the following:

1. Type K, annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use the fewest possible joints.

E. Make up-water piping, aboveground, NPS 2-1/2" and smaller, shall be:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

F. Make up-water piping, aboveground, NPS 3 to 4", shall be:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Grooved mechanical joint couplings and fittings may be used in exposed locations (not allowed above ceilings, in shafts or soffits).

G. Make up-water piping, aboveground, NPS 5" and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Grooved mechanical joint couplings and fittings may be used in exposed locations (not allowed above ceilings, in shafts or soffits).

H. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

I. Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints

J. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blow down drain is installed.

K. Air-Vent Piping:

1. Inlet: Same as service where installed.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

L. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

## 3.2 VALVE APPLICATIONS

A. Install valves as indicated on drawings and details. When not indicated on drawings / details at a minimum provided valves as indicated in 3.2.B through G.

B. Install shutoff-duty valves at branch connection to supply mains, and at supply/return connections to each piece of equipment.

C. Install shutoff valves in each supply and return line at each floor and building wing.

D. Install balancing valves at each branch connection to return main.

E. Install balancing valves at each floor and building wing return main.

F. Install balancing valves in the return pipe of each heating terminal and at each piece of equipment.

G. Install check valves at each pump discharge and elsewhere as required to control flow direction.

H. Install safety valves at hot-water generators / pressure vessels and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

I. Install pressure-reducing valves with strainer and isolation valve at makeup-water connection to regulate system fill pressure.

## 3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

P. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

Q. Install valves according to Division 23.

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

T. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, balancing valve and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

U. Install expansion loops, expansion joints, anchors, and pipe alignment guides.

V. Identify piping as specified in Division 23.

W. Provide flexible connections in piping at all building expansion joints. See architectural drawings for building expansion joint locations.

## 3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

## 3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.

3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
13. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
14. NPS 18: Maximum span, 28 feet; minimum rod size, 1-1/4 inches.
15. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch
7. NPS 4: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

## 3.6 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

## 3.7 HYDRONIC SPECIALTIES INSTALLATION

A. Install automatic air vents at all high points of system piping in mechanical equipment rooms/spaces only. Manual vents at heat-transfer coils and elsewhere as required for air venting. Pipe discharge of automatic and manual air vents to nearest floor drain.

B. Install piping from boiler air outlet or air separator to expansion tank with a 2 percent upward slope toward tank.

C. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

D. Install bladder tanks per manufacturer's instructions. Install tank fitting and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tanks from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

E. Install vertical expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

F. Provide 4" concrete pad beneath pressure fill systems. Install per manufacturers recommendations. Select associated pressure regulators for required system fill pressure in mid span of regulator range.

G. Provide flex connectors at all pumps / chillers and as noted on drawings and details.

H. Install hydronic flow / BTU meters furnished under 230900. Installations shall comply with manufacturers requirements. Coordinate all meter and display locations/orientations in the field with the meter manufacturer.

## 3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23.

## 3.9 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

B. Provide cleaning/flushing and chemical treatment per 232500.

C. Add initial chemical treatment and maintain water quality as recommended by chemical treatment company for the first year of operation.

D. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:

1. Hot-Water Heating Piping: Minimum 30 percent propylene glycol.
2. .

## 3.10 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Clean hydronic systems per 232500.
4. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
5. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used (compressed air may not be used).
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than the greater of 100 PSI or 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

**END OF SECTION**

**SECTION 23 21 23**

**HYDRONIC PUMPS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 22, 23 and 26 apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.
3. Automatic condensate pump units.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data (With close-out documents): For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

## 2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Bell & Gossett; Div. of ITT Industries.
4. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve or Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N (< 225deg F operating conditions) / EPT (=> 225 deg F) bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings (< 5HP) / Oil lubricated; bronze-journal or thrust type (=> 5HP).

D. Motor: Single speed, with permanently lubricated (< 5HP) / grease-lubricated (=>5HP) ball bearings, unless otherwise indicated; and rigidly mounted to pump casing.

## 2.3 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Bell & Gossett; Div. of ITT Industries.
4. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve or Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N (< 225deg F operating conditions) / EPT (>= 225 deg F) bellows and gasket.
5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, with permanently lubricated (5HP and smaller) / grease-lubricated (over 5HP) ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment.

## 2.4 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers:

1. Aurora Pump; Division of Pentair Pump Group.
2. Flowserve Corporation; Div. of Ingersoll-Dresser Pumps.
3. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
4. MEPCO (Marshall Engineered Products Co.).

B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve, alarm dry contact for building automation interface and a 72-inch minimum, electrical power cord with plug.

## 2.5 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast or ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast or ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Base Mounted Pumps: Install concrete bases of 6” tall and 6” larger in all dimensions of pump including inertia base and springs.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 3.

3.3 PUMP INSTALLATION

A. Comply with ANSI/HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Fabricate brackets or supports as required.

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight.

F. Set base-mounted pumps with inertia pad and spring isolators on concrete base. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

G. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

## 3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate / frame / inertia base with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

## 3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install pump trim as indicated on drawing details.

F. When drawing pump details are not provided, install triple-duty valve on discharge side of pumps.

G. When drawing pump details are not provided, install Y-type strainer (in-line or vertical split case pumps) / suction diffuser (end suction pumps) and shutoff valve on suction side of pumps.

H. When drawing pump details are not provided, install flexible connectors (double spherical type with control rods or cables) on suction and discharge sides of base-mounted pumps between pump casing and valves.

I. When drawing pump details are not provided, install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

J. Install check valve and gate or ball valve on each condensate pump unit discharge.

K. Install electrical connections for power, controls, and devices.

L. Ground equipment according to Division 26.

M. Connect wiring according to Division 26.

## 3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:
    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 1 Closeout Procedures & Demonstration and Training.

**END OF SECTION**

**SECTION 23 23 00**

**REFRIGERANT PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Divisions 22, 23 and 26 apply to this section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 DEFINITIONS

A. Not applicable.

1.4 SUBMITTALS: Provide Items A & B as indicated below along with VRF equipment submittal per spec 235701. Also indicate condensate drain lines associated with VRF system.

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings (Shop drawings shall be approved prior to installation of any products or components): Show layout (fabrication drawings) of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment. Shop drawing shall be created in AutoCAD latest edition. Copies of design drawings are not acceptable.

1. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).

2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Record Drawings: Show corrected layout (fabrication drawings) of actual refrigerant piping and specialties installation, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment. Record drawings shall be created in AutoCAD latest edition. Copies of design drawings are not acceptable. Provide both paper copy (five full size) and electronic AutoCAD files.

1. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).

D. Operation and Maintenance Data: Refrigerant valves, piping specialties and field quality control test reports (see Part 3).

## 1.5 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

## 1.6 DELIVERY STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

## 1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7.

## 1.8 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

## 1.9 WARRANTY

A. Written manufacturers' warranty covering parts and labor for a period of one year from substantial completion, or eighteen months from shipment, whichever is longer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS:

A. Subject to compliance with requirements, provide refrigerants by one of the following manufacturers:

1. Refrigerants:
   a. Atofina Chemicals, Inc.
   b. DuPont Company; Fluorochemicals Div.
   c. Honeywell, Inc.; Genetron Refrigerants.
   d. INEOS Fluor Americas LLC.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR or type K complying with ASTM B88 or ASTM B819.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: socket.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 115-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: socket.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

H. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

I. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

J. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig.
7. Rated Flow: <Insert tons (kW).>
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

K. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig.
7. Rated Flow: <Insert tons (kW).>
8. Working Pressure Rating: 500 psig.

9. Maximum Operating Temperature: 240 deg F.

L. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

M. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

N. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

A. R-410A: Pentafluoroethane/Difluoromethane.

**PART 3 - EXECUTION**

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR or K, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines: Copper, Type ACR or K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR or K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install packed-angle valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install packed-angle valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

## 3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Pipe sizes shown on drawings are preliminary. All sizing shall be by the equipment manufacturer based on actual layout. Equipment manufacturer shall review and approve routing, sizing, sloping and components for a complete and fully functional system.

C. Install refrigerant piping according to ASHRAE 15.

D. All refrigerant circuits shall be designed to contain less than 100 lbs of refrigerant such that City of Chicago Code fireman dump valves are not required.

E. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

H. Install piping adjacent to machines to allow service and maintenance.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Refer to Division 23 for solenoid valve controllers, control wiring, and sequence of operation.

M. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

N. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 8 if valves or equipment requiring maintenance is concealed behind finished surfaces.

O. Install refrigerant piping in protective conduit where installed belowground.

P. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

Q. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.
5. Slopes shall comply with equipment manufacturers requirements.

R. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

S. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

T. Seal penetrations through fire and smoke barriers according to Division 7.

U. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

V. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

W. Seal pipe penetrations through exterior walls according to Division 7 for materials and methods.

X. Identify refrigerant piping and valves according to Division 23.

Y. Provide flexible connections in piping at all building expansion joints. See architectural drawings for building expansion joint locations.

## 3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

## 3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.

E. Support multifloor vertical runs at least at each floor.

## 3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

## 3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

## 3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

**END OF SECTION**

**SECTION 23 31 13**

**METAL DUCTS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg. Metal ducts include the following:

1. Rectangular ducts and fittings.
2. Single-wall, round, and flat-oval spiral-seam ducts and formed fittings.
3. Double-wall, rectangular, round, and flat-oval spiral-seam ducts and formed fittings.
4. Duct liner.

B. Related Sections include the following:

1. Section 230593 “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing requirements for metal ducts.

2. Section 233300 “Air Duct Accessories” for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

### 1.3 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
2. Joints: Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Hanger and Support Design: Hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.5 SUBMITTALS

A. Shop Drawings (Shop drawings shall be approved prior to the installation of any products or components): AutoCAD-generated and drawn to 1/4-inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Indicate locations of all ducted equipment and duct accessories per spec 233300 Copies of design drawings are not acceptable.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment and vibration isolation.

B. Submit with close-out documents:
1. Field quality-control test reports.
2. Record Drawings: AutoCAD-generated and drawn to 1/4 inch equals 1 foot scale. Provide corrected fabrication shop drawing showing actual routing of ventilation system. Copies of shop drawing or design drawings are not acceptable. Provide both AutoCad files and full size paper copies (quantity five).
   a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   b. Installed duct layout indicating sizes and pressure classes.
   c. Elevations of top and bottom of ducts.
   d. Dimensions of main duct runs from building grid lines.
   e. Fittings.
   f. Reinforcement and spacing.
   g. Seam and joint construction.
   h. Penetrations through fire-rated and other partitions.
   i. Equipment installation based on equipment being used on Project.
   j. Duct accessories, including access doors and panels.
   k. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.6 QUALITY ASSURANCE

A. Delegated-Design:

1. Spacing of hangers and supports.
2. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

B. Welding: Qualify procedures and personnel according to AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

D. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

1.7 DELIVERY, STORAGE AND HANDLING

A. Materials delivered to the site must be coordinated with the site supervisor prior to delivery.

B. All materials shall be stored in a designated area and protected from the environment.

C. All materials shall be secured so as not to be a hazard during the construction process.

D. All materials must be free of all dirt, debris and moisture during the installation process.

1.8 WARRANTY

A. Minimum one year warranty on all material and labor from substantial completion date.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Ductmate Industries, Inc.
2. Lindab
3. Lockformer
4. McGill Airflow
5. Nexus Inc.
6. Semco, Inc.
7. Ward Industries

## 2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A 653/A 653M and having G90 coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 2 mils thick on opposite surfaces.

D. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

E. Stainless Steel: ASTM A 480/A 480M, Type 304 & 316.

F. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

I. Insulated Flexible Ducts: Flexible ducts wrapped with flexible glass fiber insulation, enclosed by seamless aluminum pigmented plastic vapor barrier jacket; maximum 0.23 K value at 75 degrees F.

## 2.3 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes combinations of open-weave fabric strips and mastics.

B. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

C. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

D. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

## 2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

## 2.5 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.

2. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

## 2.6 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Flat-Oval, Longitudinal- and Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible. Fabricate ducts larger than 72 inches in diameter with butt-welded longitudinal seams.

D. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
4. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
5. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

E. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

F. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

G. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:

a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.

3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:

a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.

4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
6. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
8. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
10. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.
11. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

H. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.
2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
3. Round Elbows 28 to 60 Inches in Diameter: Standard gored construction, riveted and bonded.
4. Other Fittings: Riveted and bonded joints.
5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.

## 2.7 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. McGill AirFlow LLC.
2. Sheet Metal Connectors, Inc.
3. Approved equal.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: 304 stainless steel (outdoor application) / G90 galvanized steel (indoor application) complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.

G. Inner Duct: Minimum 0.028-inch solid sheet steel.

H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.8 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: 304 stainless steel (outdoor application) / G90 galvanized steel (indoor application) complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Inner Duct: Minimum 0.028-inch solid sheet steel.

E. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts (indoor application): 1-1/2 inches thick.
2. Supply Air Ducts (outdoor application): 2 inches thick.
3. Return Air Ducts (outdoor application): 2 inches thick.
4. Exhaust Air Ducts (outdoor application): 2 inches thick.

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.

## 2.9 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide glass fiber-based products by one of the following:

    a. Certainteed Corporation; Insulation Group (Tough Guard Rigid Liner Board).
    b. Johns Manville (Permacok Liner Acoustic R300).
    c. Knauf Insulation (Sonic XP).
    d. Owens Corning (Fiberglass Duct Liner Board).

2. Maximum thermal conductivity:

    a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F. Internal duct liner shall be 2 to 4 pounds per cubic foot, 1 inch thick with a minimum R-3.5 resistance.
    b. Comply with insulation spec 230715.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
2. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

    a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter

D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.

9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

**PART 3 - EXECUTION**

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts (fan coils, ducted IU, constant volume units excluding units specifically called out elsewhere): +2.

2. Supply Ducts (MAU, ducts outdoors, ducts in shafts): +4".
3. Supply Ducts (between fan and first system fire damper): +8".
4. Return/Exhaust Ducts (between nearest fire damper and return/exhaust fan inlet, ducts in shafts, ducts outdoors): -4".
5. Exhaust Ducts not called out elsewhere (Negative Pressure): -2".

B. All ducts shall be galvanized steel except as follows:

1. Laundry Supply, Outside Air and Exhaust:

   a. Aluminum, with welded seams. No sheet metal screws. Smooth interior.

2. Locker room / shower room / toilet exhaust ducts (wash-down or high humidity areas):

   a. Aluminum with seams and laps arranged on top of duct.

3. Outdoor exposed uninsulated ductwork (eg. RTU air intake ductwork extension):

   a. Aluminum with welded seams.

4. Fully Exposed Supply Ducts:

   a. Round/oval galvanized sheet steel with paint grip finish.

## 3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7.

O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

P. Provide flexible connections in ductwork at all building expansion joints. See architectural drawings for building expansion joint locations.

Q. Ductwork on roof shall be installed on permanent roof supports flashed into the roof. Clearance between bottom of duct and roof finished surface shall be the greater of as indicated on drawings or 18 inches. Provide neoprene isolation between ductwork and roof/unit supports.

R. Paint interior of supply, return, general exhaust, and toilet exhaust ductwork flat-black within 4 ft of diffusers and grilles to reduce light reflecting in ductwork. Do not paint kitchen exhaust, hazardous exhaust, trash room exhaust or dishwasher exhaust.

## 3.3 DUCT LINER INSTALLATION

A. Install Duct liner (flexible elastomeric) only in the following ductwork:

1. Indoor supply/return/exhaust ductwork associated within 25 feet of MAUs/RTUs.
2. Transfer ducts.

## B. SEAM AND JOINT SEALING

C. Seal all duct seams and joints to the most severe requirement between the latest Chicago Building Code and SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

D. Utilize sealant designed for outdoor use with ductwork exposed to the outdoors.

E. Seal ducts before external insulation is applied.

## 3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

D. For concrete structure installations: Install concrete inserts before placing concrete.

E. For concrete structure installations: Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

## 3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Ducts with a Pressure Class positive 3-Inch wg or greater: Test 100% of duct work.
    b. Supply Ducts with a Pressure Class of positive 2 Inch wg: Test representative duct sections, selected by EOR/CxA from sections installed, totaling no less than 25 percent of total installed duct in accessible locations, 100% of ductwork in shafts / above hard ceilings / exposed on roofs and 100% of ductwork on the first level above the ceiling.
    c. Return / Exhaust Ducts with a Pressure Class of negative 2 Inch wg: Test representative duct sections, selected by EOR/CxA from sections installed, totaling no less than 25 percent of total installed duct in accessible locations, 100% of ductwork in shafts / above hard ceilings / exposed on roofs and 100% of ductwork on the first level above the ceiling.
    d. Return / Exhaust Ducts with a Pressure Class of negative 3 to negative 8 Inch wg: Test 100% of ductwork.

e. Outdoor-Air Ducts: Test 100% of ductwork.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to the greater of the maximum design pressure or rating pressure of the associated duct. Do not pressurize systems above maximum duct rating pressure.
7. Give seven days' advance notice for testing.
8. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round and flat-oval ducts, Leakage Class 16 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 4 for pressure classes from 2- to 10-inch wg.
9. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.7 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and reinspect ducts.

G. Cleaning existing ductwork: Use service openings, as required, for physical and mechanical entry and for inspection.

1. Use existing service openings where possible.
2. Create other openings to comply with duct standards.
3. Disconnect flexible ducts as needed for cleaning and inspection.
4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
5. Remove and reinstall ceiling sections to gain access during the cleaning process.

H. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.

I. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.

J. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

K. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide operative drainage system for washdown procedures.
7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

L. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and reinspect ducts.

M. Gravimetric Analysis: At discretion and expense of Owner, sections of metal duct system, chosen randomly by Owner, may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.

1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal duct system shall be re-cleaned and re-verified.

N. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop

is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

**END OF SECTION**

**SECTION 23 33 00**

**AIR DUCT ACCESSORIES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Manual volume damper cable operator
4. Fire dampers.
5. Smoke dampers.
6. Combination fire smoke dampers.
7. Duct silencers (Sound attenuators)
8. Turning vanes.
9. Duct-mounting access doors.
10. Pressure relief access doors.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.

### 1.3 DEFINITIONS – NOT APPLICABLE

### 1.4 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Fire dampers.
4. Manual volume damper cable operator
5. Smoke dampers.
6. Combination fire smoke dampers.
7. Duct silencers. (Sound attenuators)
8. Turning vanes.
9. Duct-mounting access doors.
10. Flexible connectors.

11. Flexible ducts.
12. Duct accessory hardware

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Indicate all duct accessories in coordination ductwork drawing per spec 233113.

1. Special fittings.
2. Backdraft dampers.
3. Manual-volume damper installations.
4. Manual volume damper cable operator locations
5. Motorized-control damper installations.
6. Fire-damper, smoke-damper, and combination fire- and smoke-damper installations, including sleeves and duct-mounting access doors.
7. Duct silencers (Sound attenuators)
8. Duct mounted access doors.
9. Pressure relief access doors.
10. Flexible connectors.
11. Flexible ducts.
12. Wiring Diagrams: Power, signal, and control wiring.

## 1.5 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

## 1.6 DELIVERY, STORAGE AND HANDLING

A. Materials delivered to the site must be coordinated with the site supervisor prior to delivery.

B. All materials shall be stored in a designated area and protected from the environment.

C. All materials shall be secured so as not to be a hazard during the construction process.

D. All materials must be free of all dirt, debris and moisture during the installation process.

## 1.7 WARRANTY

A. Minimum one year warranty on all material and labor from substantial completion date.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Backdraft Dampers:

    a. Greenheck
    b. Ruskin
    c. Vent Products Company

2. Volume Dampers

    a. Nailor
    b. Ruskin
    c. Vent Products Company

3. Manual Volume Damper Cable Operator

    a. Metropolitan Air Technology
    b. Approved Equal

4. Fire Dampers

    a. Greenheck
    b. Ruskin
    c. Vent Products Company

5. Smoke Dampers

    a. Greenheck
    b. Ruskin
    c. Vent Products Company

6. Combination Fire and Smoke Dampers

    a. Greenheck Fan Corporation.
    b. Ruskin Company.
    c. Vent Products Company

7. Duct Silencers (Sound attenuators)
    a. Ruskin
    b. Vibro-Acoustics
    c. Price

8. Duct-Mounting Access Doors

    a. CESCO Products
    b. Ductmate Industries

c. Greenheck

9. Flexible Connectors

a. Ductmate Industries
b. Ventfabrics, Inc.
c. Ward Industries

10. Flexible Ducts

a. Flexmaster USA
b. Hart & Cooley, Inc.
c. McGill Airflow Corp.

## 2.2 SHEET METAL MATERIALS

A. Duct accessory shall match material of ductwork, refer to section 233113.

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

C. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

D. Stainless Steel: ASTM A 480/A 480M Type 304 (specify Type 314 as required by the application).

E. Aluminum Sheets: ASTM B 209 alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

F. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.

G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 BACKDRAFT DAMPERS

A. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

B. Frame: 0.063-inch thick extruded aluminum, with welded corners and mounting flange.

C. Blades: 0.050-inch thick aluminum sheet.

D. Blade Seals: Neoprene.

E. Blade Axles: Galvanized steel.

F. Tie Bars and Brackets: Galvanized steel.

G. Return Spring: Adjustable tension.

## 2.4 VOLUME DAMPERS

A. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel. Drive shaft will be the full length of the blade.
7. Bearings: Stainless-steel sleeve.
8. Tie Bars and Brackets: Aluminum.
9. Tie Bars and Brackets: Galvanized steel.

C. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Aluminum Frames: 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.

4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Galvanized steel. Drive shaft will be the full length of the blade.
7. Bearings: Stainless-steel sleeve thrust or ball.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered stainless steel.
10. Tie Bars and Brackets: Aluminum.

D. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

F. Manual Volume Damper Cable Operator: Heavy duty universal damper drive, cable, termination, mounting brackets and mini ceiling cup (1" diameter). Similar to Metropolitan Air Technology (Round Ducts: MAT RT-250 with RT-WGA and RT-CCM, Rectangular Ducts: MAT-RT-200 with RT-WGA and RT-CCM) with mounting bracket and miniature ceiling cup. Hex nut driven.

## 2.5 FIRE DAMPERS

A. Fire dampers shall be Dynamic; rated and labeled according to UL 555 by an NRTL.

B. Closing rating in ducts up to 8-inch wg static pressure class and minimum 4000-fpm> velocity.

C. Fire Rating: 1-1/2 and 3 hours. See life safety drawings for assembly wall and floor ratings.

D. Fire Rating: Insert rating as required by application hours.

E. Frame: Curtain type with blades outside airstream fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Fusible Links: Replaceable, 165 deg F rated.

K. Fire dampers in ductwork serving natatorium / locker / toilet / shower areas shall be aluminum or 316 stainless steel construction.

2.6 SMOKE DAMPERS

A. General Requirements: Label according to UL 555S by an NRTL.

B. Smoke Detector: Integral, factory wired for single-point connection.

C. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners and mounting flange.

D. Blades: Roll-formed, horizontal, interlocking or overlapping, 0.034-inch-thick, galvanized sheet steel.

E. Leakage: Class I.

F. Rated pressure and velocity to exceed design airflow conditions.

G. Mounting Sleeve: Factory-installed, 0.039-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

H. Damper Motors: two-position action.

I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Electrical Connection: 24 V. Provide step down transformer.

J. Accessories:

1. Auxiliary switches for signaling and position indication.
2. Test and reset switches, damper mounted.

## 2.7 COMBINATION FIRE AND SMOKE DAMPERS

A. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

B. Closing rating in ducts up to 8-inch wg static pressure class and minimum 4000-fpm> velocity.

C. Fire Rating: 1-1/2 and 3 hours. See life safety drawings for assembly wall and floor ratings.

D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded, interlocking, gusseted or mechanically attached corners and mounting flange.

E. Heat-Responsive Device: Resettable, 212 deg F rated, fire-closure device.

F. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.

G. Smoke Detector: Integral, factory wired for single-point connection.

H. Blades: Roll-formed, horizontal, interlocking, overlapping, 0.063-inch thick, galvanized sheet steel.

I. Leakage: Class I.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

L. Master control panel for use in dynamic smoke-management systems.

M. Damper Motors: two-position action.

N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Electrical Connection: 24V. Provide step-down transformer.

O. Accessories:

1. Auxiliary switches for signaling and position indication.
2. Test and reset switches, damper mounted.

## 2.8 DUCT SILENCERS (SOUND ATTENUATORS)

A. General Description: Factory-fabricated and -tested, round or rectangular silencers with performance characteristics and physical requirements as indicated.

B. Fire Performance: Adhesives, sealants, packing materials, and accessory materials shall have fire ratings not exceeding 25 for flame-spread index and 50 for smoke-developed index when tested according to ASTM E 84.

C. Rectangular Units: Fabricate casings with a minimum of 0.034-inch- thick, solid galvanized sheet metal for outer casing and 0.022-inch- thick, ASTM A 653/A 653M, G90perforated galvanized sheet metal for inner casing.

D. Round Units:

1. Outer Casings:

a. ASTM A 653/A 653M, G90 galvanized sheet steel.
b. Up to 24 Inches in Diameter: 0.034 inch thick.
c. 26 through 40 Inches in Diameter: 0.040 inch thick.
d. 42 through 52 Inches in Diameter: 0.052 inch thick.
e. 54 through 60 Inches in Diameter: 0.064 inch thick.
f. Casings fabricated of spiral lock-seam duct may be one size thinner than that indicated.

2. Interior Casing, Partitions, and Baffles:

a. ASTM A 653/A 653M, G90, galvanized sheet steel.
b. At least 0.034 inch thick and designed for minimum aerodynamic losses.

E. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.

F. Fill Material: Moisture-proof nonfibrous material.

1. Erosion Barrier: Polymer bag enclosing fill and heat-sealed before assembly.

G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.

1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
2. Lock form and seal or continuously weld joints.

3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
4. Reinforcement: Cross or trapeze angles for rigid suspension.

H. Source Quality Control:

1. Acoustic Performance: Test according to ASTM E 477.
2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm face velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

## 2.9 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

D. Turning vane material shall match the associated ductwork the vanes are installed in (i.e. aluminum ducts shall have aluminum turning vanes, etc.)."

## 2.10 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
2. Provide number of hinges and locks as follows:

a. Less than 12 Inches Square: Secure with two sash locks.
b. Up to 18 Inches Square: Two hinges and two sash locks.
c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

F. Duct mounted access door material shall match the associated ductwork the doors are installed in (i.e. aluminum ducts shall have aluminum doors, etc.)."

## 2.11 FLEXIBLE CONNECTORS

A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

D. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

## 2.12 FLEXIBLE DUCTS

A. Insulated-Duct Connectors: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F

B. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

## 2.13 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Balancing dampers may not be shown in all locations on the drawings. The contractor shall provide manual balancing dampers in all supply / return / exhaust / outside air ductwork at all diffusers, registers, grilles, at outside air connections to fan coil units, at fan coil unit / fan powered box supply discharge (after the ductwork has expanded but before the first duct take-off), at all floor mains, at all duct branches and as required to balance all systems (Note: Not all dampers are shown on the drawings) while meeting the project sound requirements.

E. Provide remote cable operator for manual balancing dampers located above drywall/plaster/metal ceilings/walls. Cable length as required to install in accessible location coordinated with all items in ceilings and walls. Terminate with ceiling/wall paintable mini cup cap (flush to surface) to hide hex nut driver. Custom color as selected by architect.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Provide fire dampers / smoke dampers / fire smoke dampers where indicated on the drawings and as required to comply with the City of Chicago Building Code, the International Building Code, the International Mechanical Code and NFPA 90A (Note: Not all dampers are shown on the drawings). See architectural drawings for fire/smoke ratings of walls/floors/ceilings/shafts/soffits. Fire dampers / smoke dampers / combination fire smoke dampers shall be installed in accordance with UL approved written instructions.

H. Install fire dampers, smoke dampers and combination fire smoke dampers according to manufacturer’s UL approved written instructions.

I. Install duct silencers rigidly to ducts.

J. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides (upstream and downstream) of ducted coils. On terminal units coordinate upstream coil access door with equipment supplier.
2. Downstream from volume dampers, turning vanes, and duct mounted equipment.
3. Adjacent to fire dampers, providing access to reset or reinstall fusible links.

4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available.
6. As required or indicated on plans.
7. Upstream and downstream of ducted fans.
8. Kitchen hood exhaust: At every change in direction, at the base of risers, at connections to hoods and every 20’-0”.

K. Label access doors according to Division 23 Section "Mechanical Identification."

L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. Install duct access doors upstream and downstream of air coils.

N. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to low pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

R. Install duct test holes where indicated and required for testing and balancing purposes.

S. Provide turning vanes in all short radius / square elbows (>45 degrees) and tees.

T. Provide flexible connections in ductwork at all building expansion joints. See architectural drawings for building expansion joint locations.

## 3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

3.3 CLEANING – NOT APPLICABLE

3.4 CONTRACTOR STARTUP AND REPORTING – NOT APPLICABLE

3.5 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the duct accessories.

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining duct accessories. The training will occur after testing and balancing. The trainer will provide two (2) Installation and Operations manuals for the use of the Owner's personnel during training.
2. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data." All required and recommended maintenance will be reviewed as well as operational trouble shooting. If the IOM does not include a written trouble shooting guide one will be provided.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

B. Demonstrate proper operation of duct accessories to commissioning agent or designated Owner's personnel. The scope of the demonstration will include functional performance requirements under both stand alone and building automation control (when identified in control documents) as well as any commissioning requirements in Division 1 or 23.

1. For all fire dampers or access doors for fire dampers installed on this project the Contractor will demonstrate that any fire dampers selected by the owner can be dropped and reset using the provided access doors.

**END OF SECTION**

**SECTION 23 34 23**

**HVAC POWER VENTILATORS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 22, 23 and 26 apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Centrifugal roof ventilators.
2. Upblast propeller roof exhaust fans.
3. Centrifugal wall ventilators.
4. In-line centrifugal fans (Non-Mixed Flow Fans).
5. Utility Set fans

1.3 DEFINITIONS – NOT APPLICABLE

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Provide wiring Diagrams: Power, signal, and control wiring.

C. Submit with close-out documents: Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1. Field Quality-Control Test Reports: Submit reports (static/dynamic field balancing, etc.) documenting the activities required to be performed in Part 3.

Field balancing shall be complete within 2 weeks of startup and prior to test and balance.

2. Training Reports.

## 1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

## 1.7 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

## 1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

## 1.9 EXTRA MATERIALS

A. Furnish one set of spare belts for each fan that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.10 WARRANTY

A. Provide manufacturer's standard form in which manufacturer agrees to replace components of fans that fail in materials or workmanship within one year after date of substantial completion or date of owner acceptance.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide diffusers by one of the following:

1. Centrifugal Roof Ventilators:

    a. Greenheck.
    b. Loren Cook Company.
    c. Penn Ventilation.
    d. Twin Cities

2. Upblast Propeller Roof Exhaust Fans:

    a. Greenheck.
    b. Loren Cook Company.
    c. Penn Ventilation.
    d. Twin Cities

3. Centrifugal Wall Ventilators:

    a. Greenheck.
    b. Loren Cook Company.
    c. Penn Ventilation.
    d. Twin Cities

4. In-line Centrifugal Fans (Non-Mixed Flow Fans):

    a. Greenheck.
    b. Loren Cook Company.
    c. Penn Ventilation.
    d. Twin Cities

5. Utility Set Fans:

    a. Greenheck.
    b. Loren Cook Company.
    c. Penn Ventilation.
    d. Twin Cities

## 2.2 CENTRIFUGAL ROOF VENTILATORS

A. Description: Direct- or belt-driven centrifugal fans as scheduled consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly (Provide direct drive for all units less then ½ HP): Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent. All single phase power fans.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers (as scheduled) Counterbalanced, parallel-blade, back draft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers (as scheduled): Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base. 24” high (Minimum 14” above finished roof).
7. Hinge kit with restraint cables.
8. One set of each size sheave available for each fan for field changeout during test and balance to achieve design cfm.
9. Shaft grounding rings.
10. Electronically commutated (EC) motor with controller, pressure transducer and remote sensor to maintain constant pressure in the upstream exhaust duct for residential toilet exhaust and residential kitchen exhaust systems.

## 2.3 UPBLAST PROPELLER ROOF EXHAUST FANS

A. Description: Direct- or belt-driven propeller fans consisting of housing, wheel, butterfly-type discharge damper, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

C. Damper Rods: Steel with bronze bearings.

D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Belt-Driven Drive Assembly (Provide direct drive units for all units less then ½ HP): Resiliently mounted to housing; weatherproof housing of same material as fan housing with the following features:

F. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

1. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
2. Pulleys: Cast-iron, adjustable-pitch motor pulley.
3. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base.

H. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent. All single phase power fans.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base. Minimum fan discharge 40” above finished roof.
5. Hinge kit with restraint cables.
6. One set of each size sheave available for each fan for field changeout during test and balance to achieve design cfm.
7. Shaft grounding rings.
8. Electronically commutated (EC) motor with controller, pressure transducer and remote sensor to maintain constant pressure in the upstream exhaust duct for residential toilet exhaust and residential kitchen exhaust systems.

## 2.4 CENTRIFUGAL WALL VENTILATORS

A. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

E. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

1. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
2. Pulleys: Cast-iron, adjustable-pitch motor pulley.
3. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent. All single phase power fans.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Wall Grille: Ring type for flush mounting.
5. Dampers (as scheduled) Counterbalanced, parallel-blade, back draft dampers mounted in curb base; factory set to close when fan stops.
6. Motorized Dampers (as scheduled): Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
7. One set of each size sheave available for each fan for field changeout during test and balance to achieve design cfm.
8. Shaft grounding rings.
9. Electronically commutated (EC) motor with controller, pressure transducer and remote sensor to maintain constant pressure in the upstream exhaust duct for residential toilet exhaust and residential kitchen exhaust systems.

## 2.5 IN-LINE CENTRIFUGAL FANS (NON-MIXED FLOW FANS)

A. Description: In-line, belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent. All single phase power fans.
2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
3. Companion Flanges: For inlet and outlet duct connections.
4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
5. One set of each size sheave available for each fan for field changeout during test and balance to achieve design cfm.
6. Shaft grounding rings.
7. Electronically commutated (EC) motor with controller, pressure transducer and remote sensor to maintain constant pressure in the upstream exhaust duct for residential toilet exhaust and residential kitchen exhaust systems.

2.6 MOTORS

A. Comply with requirements in Division 23 Section "Motors."

B. Enclosure Type: Totally enclosed, fan cooled.

2.7 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using spring isolators having a static deflection of 1 inch.

C. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

D. Install floor-mounting units on concrete bases. Provide 4” high concrete bases.

E. Secure roof-mounting fans to roof curbs with cadmium-plated hardware

F. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

G. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch.

H. Install roof mounted in-line fans on 24" roof curb (minimum 14" above finished roof) with spring vibration isolators.

I. Install units with clearances for service and maintenance.

J. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

K. Replace / resize sheaves during/after test and balance to achieve design cfm at static.

L. Provide electronically commutated (EC) motors on all single phase power exhaust fans. Fans connected to a group of residential kitchen hoods or spaces with motorized dampers operated off of user switches or occupancy sensors shall include a factory controller and differential pressure transducer with remote sensor in upstream ductwork modulating fan to maintain a duct static setpoint. Coordinate setpoint in field with test and balance. Provide devices and field wiring for a complete installation. Install per manufacturer's recommendation.

## 3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

## 3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

## 3.4 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."

C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

D. Demonstrate operation of power ventilators. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each power ventilator.

## 3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

## 3.6 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

## 3.7 CONTRACTOR STARTUP AND REPORTING

A. Final Checks before Startup: Perform the following operations and checks before startup. Startup service includes the testing, inspections and startup test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts, and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
7. Disable automatic temperature-control operators.

B. Starting procedures for fans are as follows:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
2. Measure and record motor voltage and amperage.

C. Shut unit down and reconnect automatic temperature-control operators.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

E. Replace fan and motor pulleys as required to achieve design conditions.

## 3.8 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fans. Refer to Division 1 Section "Demonstration and Training."

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining fans. The training will occur after the startup report has been provided to the owner and the trainer will provide two (2) Installation and Operations manuals for the use of the owner's personnel during training.
2. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data." All required and recommended maintenance will be reviewed as well as operational trouble shooting. If the IOM does not include a written trouble shooting guide one will be provided.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

B. Demonstrate proper operation of equipment to commissioning agent or designated owners personnel. The scope of the demonstration will include functional performance requirements under both local and building automation control as well as any commissioning requirements in Division 1 and 23.

**END OF SECTION**

**SECTION 23 36 00**

**AIR TERMINAL UNITS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:
   1. Constant flow regulator (high pressure), air terminal unit.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air terminal units.

   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:

   1. Materials, fabrication, assembly, and spacing of hangers and supports.
   2. Include design calculations for selecting hangers and supports.

### 1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Include location of air terminal units on ductwork coordination drawings. Refer to Spec 23 3113. Coordinate access.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Instructions for resetting minimum and maximum air volumes.

**PART 2 - PRODUCTS**

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 CONSTANT FLOW REGULATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Aldes; CAR-II-LP /CAR-II-HP
2. Hidria; RM/RMV
3. SIVAR; CAR-LP/CAR-HP

B. General: Modulating orifice that automatically regulates airflows in duct system to constant levels. The passive control element responds to duct pressure and requires no electric or pneumatic sensors or controls.

C. Air temperature range: -25°F to 140°F.

D. Construction: UL 2043 safety classified and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, when tested according to ASTM E 84.

E. Performance: regulator shall control airflow accurately to within 10% of rated flow (15% for units 50 CFM or less), throughout the target operating pressure range of LP(0.2 to 0.8) or HP (0.6 and 02.4) in. w.g. Unit shall be factory tested and calibrated. On-site field adjustment of airflow set points shall be possible.

F. Warranty: 5 years from date of shipment against all defects in material or workmanship, provided equipment has been installed and used under normal conditions. This warranty is limited to the repair and/or replacement of the equipment.

**PART 3 - EXECUTION**

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.3 CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange. See drawings for additional requirements.

C. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units. See drawings for additional requirements.

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories." See drawings for additional requirements.

## 3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.

3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

**END OF SECTION**

**SECTION 23 37 13**

**DIFFUSERS, REGISTERS, AND GRILLES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Divisions 22, 23, and 26 apply to this section.

### 1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Requirements:

1. Section 233300 “Air Duct Accessories” for fire and smoke dampers and volume-control dampers not integrated to diffusers.

### 1.3 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

### 1.4 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Provide Diffuser, Register, and Grille Schedule indicating each device materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings at design airflow (Peak airflow for VAV systems). Include. room number/ location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

## 1.5 QUALITY ASSURANCE

A. ARI Compliance: Test and rate diffusers, registers, and grilles in accordance with ARI 650 "Standard for Diffusers, registers, and grilles".

B. ASHRAE Compliance: Test and rate diffusers, registers, and grilles in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

C. ADC Compliance: Test and rate diffusers, registers, and grilles in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

D. ADC Seal: Provide diffusers, registers, and grilles bearing ADC Certified Rating Seal.

E. NFPA Compliance: Install diffusers, registers, and grilles in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

## 1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver diffusers, registers, and grilles wrapped in factory-fabricated fiber- board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store diffusers, registers, and grilles in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

## 1.7 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide diffusers by one of the following:

1. Ceiling Air Diffusers:

a. Nailor
b. Titus Products Div.; Philips Industries, Inc.
c. Tuttle & Bailey; Div. of Interpace Corp.
d. Price Industries

2. Wall Registers and Grilles

a. Nailor
b. Titus Products Div.; Philips Industries, Inc.
c. Tuttle & Bailey; Div. of Interpace Corp.
d. Price Industries

2.2 CEILING AIR DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule.

2.3 WALL REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide wall registers and grilles of type, capacity, and with accessories and finishes as listed on schedule.

2.4 DOOR AND TRANSFER GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation. Provide grille on each side of transfer opening.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Construction: Outer borders shall be constructed of heavy extruded aluminum and shall have countersunk screw holes for a neat appearance. Border shall be interlocked at the four corners and mechanically staked to form a rigid frame. Extruded aluminum inverted V-blades with a deflection shall be used to create a sight proof design and provide additional stiffness to the grille.

D. Types: Provide wall grilles of type, capacity, and with accessories and finishes as listed on schedule.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
   1. Coordinate and verify in field depth required and all accessories to ensure a proper fit.

3.3 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

3.4 CONTRACTOR STARTUP AND REPORTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.5 DEMONSTRATION AND COMMISSIONING – NOT APPLICABLE

**END OF SECTION**

**SECTION 23 51 13.13 -**

**MECHANICAL DRYER VENTING SYSTEM**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. The intent of this specification is to provide an energy and cost-efficient mechanical venting system that will function over variable flow and maintain specified pressure at all times. The following are components of the system:

1. Packaged ETL listed ventilator/control combination, listed to UL705, Standard for Power Ventilators with special consideration given to exhaust lint laden air from clothes dryers.
2. Electrical connections.
3. Duct connection.

### 1.2 CODES AND STANDARDS

A. The following published specification standards, test or recommended methods of trade, industry or governmental organizations apply to work in the section:

1. UL – Underwriters Laboratories.
2. National Electrical Code.

### 1.3 SUBMITTALS

A. System vendor shall coordinate equipment product data submittal sheets and shall provide a comprehensive set of interfaced drawings which shall serve as the basis for system evaluation by consulting engineer.

B. Submit the following:

1. Set of mechanical venting calculations.
2. Ventilator descriptive literature, dimensional diagram and electrical diagram.
3. Control descriptive literature, dimensional diagrams and electrical diagrams. Control points list available to the building automation system through the protocol interface.
4. Specification review with respect to submitted equipment identifying all areas of compliance and exceptions.
5. Certification of listing by nationally recognized testing laboratory.
6. Documentation of Quality assurance items - 1.4 below for record. List items and indicate that the system complies.

1.4 QUALITY ASSURANCE

A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture and shall be of a standard catalog product.

B. Mechanical dryer venting system guaranteed to operate satisfactory and efficiently and to provide a constant draft that does not fluctuate more than +/- 0.01" W.C. under stable load conditions.

C. Scheduled equipment performance is minimum capacity required.

D. Scheduled electrical capacity shall be considered as maximum available.

E. Equipment to be manufactured at ISO 9001 certified plant.

1.5 MANUFACTURERS' WARRANTY

A. All equipment is to be guaranteed against defects in materials and/or workmanship for a period of 24 months from the date of delivery to the construction site. The warranty shall be provided by the equipment vendor and shall include the parts necessary to repair or replace all defective parts and materials.

1.6 OPERATING AND MAINTENANCE MANUALS

A. Submit with close-out documents, to Owner's Representative, a complete Operation and Maintenance manuals with product literature on the ventilator and controls, dimensional and wiring diagrams.

**PART 2 - PRODUCTS**

2.1 MANUFACTURER, MECHANICAL DRYER VENTING SYSTEMS

A. Furnish ENERVEX Mechanical Dryer Venting System(s) or approved equal with design volume and design pressure as scheduled on the drawings and specified. The entire system must be listed to UL 705, Standard for Power Ventilators, and bear the certification mark from ETL or other nationally recognized testing laboratory.

2.2 DESCRIPTION, MECHANICAL DRYER VENTING SYSTEM

A. The ventilator must be suitable for indoor installation. The housing shall have duct connections and be designed so the entire impeller and motor assembly can be removed as a unit. Housings must be resistant to corrosion. The design of the inlet and discharge area must assure minimum lint build-up. Fan must be rated for Type I and II lint laden air streams. It must have a service door that can be opened for easy cleaning and service. The ventilator must be rated for an operating temperature of 175°F (80°C).

B. The backward inclined impeller shall be made of cast aluminum and be completely in balance. The impeller must be balanced statically and dynamically, and balancing weights must be permanently attached. The fan complies with and meets Type B, Spark Resistant Construction per AMCA standard 99-0401

C. The motor must be a maintenance-free, variable speed motor with pre-lubricated and sealed ball bearings. Motor shall be rated for turndown ratio of 90% to provide maximum energy savings for the owner. The motor shall be factory warranted by the ventilator manufacturer to operate at frequencies as low as 8Hz for three-phase motors. The bearings must be of a high temperature type with a minimum rating of 320°F (160°C). The motor is mounted outside the airstream and shall be at least Class A insulated with a temperature rating of min. 221°F (105°C) and rated as shown on schedule. The motor must be a EC motor that does not need an exterior cooling fan. To assure motor longevity the motor shall be inverter-duty rated and not operate at speeds above 1720 RPM.

D. The modulating exhaust control, similar to Model EBC-31, must be able to maintain a constant pressure, between 0.00" W.C. and 0.6" W.C. with a tolerance of 0.01" W.C., by modulating the speed of the ventilator. The control enclosure shall be NEMA 1 rated and suitable for outdoor installations. The control shall include a pressure transducer, (similar to Model XTP2) and a duct probe with tubing, to be located in the duct as shown on the manufacturer's submittal. In addition, provide current donuts wired into the system to measure dryer activation to determine if all dryers are off and system can be shut down. The transducer shall be rated for outdoor installations and field wired to the controller.

E. The features must be part of the compliance with UL378, Standard for Draft Equipment and UL508, Standard for Industrial Controls:

1. Potentiometer to set the required duct pressure and an LCD-panel to display the value. The LCD-panel must also be able to show the actual duct pressure.
2. Electrical terminals monitored constantly via LED-diodes for verification of proper operation.
3. LED-diodes to verify ventilator operation and cycling.
4. LED-diode to indicate alarm.
5. Visual alarm to indicate insufficient duct pressure or ventilator failure.
6. Interlock with building management system. Provide a BACNET card for interface to the BAS system.
7. Interlock with each clothes dryer or a dedicated dryer electrical panel when provided.

F. Variable frequency drive, ABB Model ACS 320 listed to UL508 and listed and programmed as part of the mechanical dryer venting system. The VFD shall not be part of the PID-loop.

1. All features shall be included within the VFD enclosure. VFD shall be housed in a NEMA 1 enclosure.
2. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for fan control and to eliminate the need for motor de-rating.

3. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor.
4. VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
5. VFD shall be able to communicate via embedded Fieldbus supporting Modbus RTU (EIA-485), Johnson Controls N2, Siemens Building Technology FLN (P1), and BACnet (MS/TP).

G. Provide Clean Cycle systems Model LLS 12-14 inline style lint filter. Filter to be rated for indoor floor mounted installation, stainless steel construction Supply filter with two spare bags. Filter to include pressure gauge and dirty filter switch.

H. See drawing and schedules for additional requirements / controls.

## 2.3 PERFORMANCE, MECHANICAL DRYER VENTING SYSTEM

A. The Mechanical Dryer Venting System will ensure that the pressure set-point (in. W.C.) is reached and maintained within 30 seconds of system start-up. This can be measured with an external manometer.

B. Ramp-up and ramp-down time of the fan will be no more than 20 seconds.

C. The Mechanical Dryer Venting System will maintain the pressure in the venting system to within 0.01" W.C. of the pressure set-point (in. W.C.) when one or more dryers is on.

D. Lint filter to capture 98% of the lint and have a max pressure drop of .35" W.C. when dirty.

## 2.4 SEQUENCE OF OPERATION

A. The EBC-31 initializes when Current Transformer (CT) relay located in dedicated electrical panel is energized. The CT will be set to close when amp load coming into the dedicated panel equals one or more dryers are running. The control goes through its start-up sequence and displays the pressure readings. The draft fan is started and pressure for draft is maintained to the set points.

B. The fan will run via VFD. The fan will modulate based on the control signal to maintain pressure set point. When no dryers are in operation, the ventilator will cycle off.

C. When the user initiates dryer operation, the pressure transducer senses the change in pressure for draft and sends a signal to the controller to speed up the ventilator until the draft set-point is reached. This is repeated each time a dryer starts to operate.

D. When one or more dryers shut down, the ventilators adjusts its speed to maintain the draft set-point. When no dryers are in operation, the draft fan shall be off.

E. If proper draft pressure cannot be maintained during dryer running cycle the EBC-31 controller will go into alarm mode.

F. This equipment provider shall work with the temperature control contractor and test and balance contractor to establish the exhaust fan operating curve points (minimum 10) so that the exhaust fan operation throughout the entire operation range can be correlated to the make-up air to maintain the laundry room at negative 0.05" WC relative to the adjacent corridor if direct measurement of laundry room to corridor differential pressure is not available to the building automation system.

2.5 DUCT CONNECTION / ACCESSORIES

A. Locate controls where shown on the drawings.

B. Provide differential pressure gauge across filter unit. Provide differential pressure switch (dirty filter) with dry contacts for interface to building automation system.

2.6 ELECTRICAL REQUIREMENTS

A. Power supply shall be:

1. To the EBC-31 control: 1x120V AC, 60 Hz.
2. To the variable frequency drive: three phase power, as shown on schedule.
3. Lint filter switch, 120V.

B. All wiring shall be in accordance with the Chicago Building Code.

2.7 ALTERNATE MANUFACTURERS

A. All product substitution proposals on the basis of alternative mechanical draft system manufacturers must include detailed information regarding product performance and be UL 378 listed for the use as a dryer venting system.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Complete structural, mechanical and electrical connections in accordance with manufacturers' printed instructions.

B. Installing contractor shall install all Mechanical Dryer Venting System components as indicated on drawings, including low voltage shielded wiring from pressure transducer /Sensor to Control panel (MEC18) and line voltage wiring from Control panel (MEC18) to the ventilator. The following must be ensured:

1. Allow satisfactory arrangement in the space available.
2. Verify fan operating voltage is the equivalent to the supply voltage AND rated voltage of the VFD.

C. Connecting to the duct:

1. Install per plans in accordance with manufacturer's printed instructions.

3.2 OPERATING TESTS, START-UP AND ON-SITE SERVICES

A. Start up and project management services are to be provided by factory certified technicians. Owner training and Dryer Venting Start up report to be provided by the startup technicians.

B. Start-up procedure to include:

1. Test the operation of the Mechanical Dryer Venting System and:

a. Increase and decrease the pressure setting to verify the mechanical draft setting reacts as specified.
b. Verify that the ramp-up time during start up does not exceed 20 seconds. This is defined as the time from the burner is released until the draft settles at the specified draft value.
c. Verify the make-up air unit airflow is tracking the dryer exhaust airflow throughout the entire operating range and that the laundry room is maintained continuously at negative 0.05" WC relative to the adjacent corridor.
d. Use an external manometer (draft gauge) to verify that the draft does not drift more than 0.01" W.C. during a stable load.

2. Supervise installation of ventilator and controls.
3. Start up and adjust control.
4. Test individual controls for proper operation.
5. Set duct pressure for specified operation.
6. Test lint filter for leaks and proper bag seal.
7. Provide factory certified technicians to participate in the commissioning of the system.

C. Submit a written report signed by the manufacturer's authorized representative, confirming that safety and operating controls have been properly installed.

3.3 OPERATING INSTRUCTIONS

A. Instruct Owner's Representative and designated personnel in the proper operation and maintenance of the packaged system.

**END OF SECTION**

**SECTION 23 57 01**

**VARIABLE REFRIGERANT VOLUME SYSTEM**

## PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. All VRV Systems for this project shall be Heat Recovery Type.
2. The contractor shall provide all refrigerant piping, trim and controls associated with all equipment. Equipment selections and locations shall be coordinated with all trades prior to installation. If the contractor chooses to deviate from contract drawings and provide equipment with more refrigerant piping circuits, the additional costs associated with the deviation are the responsibility of the contractor.
3. Final quantity of refrigerant pipes / refrigerant required and final pipe sizes, layout, components shall be determined based on final pipe routing and manufacturer recommendations.

B. Refer to Section 01 9113 GENERAL COMMISSIONING REQUIREMENTS and 23 0800 COMMISSIONING OF HVAC for commissioning requirements.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. IU: Indoor Unit / cartridge, VRF fan coil unit.

B. ZB: Zone Box / Branch Selector, control valve box.

C. ACCU: Air Cooled Condensing Unit / Outdoor unit.

1.4 SUBMITTALS: submit a single comprehensive package for VRV equipment and associated piping system(s), including refrigerant piping plans per spec 232300, and condensate drain pipe /pumped condensate pipe per spec 232113

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics. Submit all information as indicated; partial submittal(s) of VRV equipment will not be accepted.

1. Provide condensing unit data sheets including the following information:
   a. Capacities at project design conditions: Cooling Cooling (Btu/h)
   b. Cooling Input Power – ductless (kW)
   c. Part Load IEER
   d. Full Load EER
   e. Capacities at project design conditions: Heating (Btu/h)
   f. Heating Input Power – ductless (kW)
   g. Full Load COP@47F – ductless
   h. Full Load COP@17F – ductless
   i. Operating Temperature Range:
      1) Cooling
      2) Heating
   j. Power Supply:
      1) Maximum Circuit Amps (MCA)
      2) Maximum Overcurrent Protection Amps (MOP)
      3) Maximum Starting Current (MSC)
   k. Condenser Fan Motor
      1) Refrigerant:
      2) Refrigerant Type/Charge
      3) Control

2. Unit Data:
   a. Max. Number of Indoor Units
   b. Sound Pressure Level at 3ft. (dBA)
   c. Weight (lbs)
   d. Dimensions

3. The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed space conditions including de-rate factors for defrost if applicable and refrigerant piping losses.
4. Provide indoor unit data sheets including the following information:
   a. Capacities at project design conditions:
      1) Cooling (Btu/h)
      2) Cooling Input Power (kW)
      3) Part Load IEER
      4) Full Load EER
      5) Heating (Btu/h)
      6) Heating Input Power (kW)
      7) Full Load COP@47F
      8) Full Load COP@17F
      9) Air Flow (CFM)
      10) External Static Pressure (ESP)
      11) Electrical Data (MCA, MOP, MSC, RLA)
      12) Weight (lbs)
      13) Dimensions

B. System layout shall fully comply with ASHRAE 15 (current edition). Provide calculations indicating each refrigerant circuit lbs of refrigerant.
   1. No single circuit of refrigerant pipe shall exceed 95 lbs of refrigerant.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Submit the following drawings:
   a. HVAC Floor Plan
   b. HVAC Refrigerant Piping Plan
   c. Pumped condensate and condensate drain piping.
   d. HVAC Refrigerant Piping/Controls Details
   e. HVAC Details
   f. HVAC Schedules

3. Provide drawing showing all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment suppliers system.
4. Wiring Diagrams: For power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Field quality-control reports.

F. Operation and Maintenance Data: For equipment to include in emergency, operation, and maintenance manuals.

G. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. The unit shall be listed by Electrical Laboratories (ETL) and bear the cETL label.

C. All wiring shall be in accordance with the National Electric Code (NEC) and the City of Chicago Building Code.

D. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

E. The outdoor unit will be factory charged with R410A.

F. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013.

H. All units and components shall fully comply with the current City of Chicago Building Code.

I. System layout shall fully comply with ASHRAE 15 (current edition).

1.7 AUTHORIZED TRAINING

A. The system must be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof with shop drawing submittal. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements. Untrained contractors who wish to bid this project shall contact the manufacturer to arrange training prior to bid day.

B. Manufacturer shall provide (6) independent 6-hour on-site installation reviews by a factory certified trainer to review field conditions for piping installation, piping support, pipe expansion, piping insulation, condensing unit clearance, and indoor unit placement. In addition, factory certified trainer shall observe and record the pressure test procedure to ensure proper startup. The pressure test procedure is as follows: The installing contractor shall ensure that the piping system is evacuated 3 times (to 4000/1500/500 microns respectively) and charged with nitrogen. The nitrogen charge must be held 3 minutes at 150 psi, 5 minutes at 325 psi, and 24 hours at 550 psi. After a successful nitrogen charring process, the installing contractor shall charge the system with the necessary additional refrigerant as prescribed by the manufacturer.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: Ten year(s) from date of Substantial Completion.
   b. For Parts: One year from date of Substantial Completion.
   c. For Labor: One year from date of Substantial Completion.

1.10 DELIVERY STORAGE AND HANDLING:

A. Unit shall be stored and handled according to the manufacturer recommendations.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Daikin.
2. Mitsubishi
3. LG
4. Trane

2.2 INDOOR UNITS

A. 1-WAY (22x37) AND 4 WAY CEILING CASSETTE UNITS (2'x2')

1. General: The indoor unit shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. Equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. The indoor units sound pressure shall be not more 33 dB(A) at low speed measured at 5 feet below the unit.
2. Indoor Unit:
   a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, brazed connections (flare not allowed), condensate drain pan, condensate pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
   b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
   c. Both refrigerant lines shall be insulated from the outdoor unit.
   d. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
   e. Return air shall be through the concentric panel, which includes a mold resistant filter.

f. The indoor units shall be equipped with a condensate pan and condensate pump.
g. The indoor units shall be equipped with a return air thermistor.
h. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
i. The voltage range will be 253 volts maximum and 187 volts minimum.

3. Unit Cabinet:
   a. The cabinet shall be space saving and shall be located into the ceiling.
   b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
   c. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
   d. A branch duct knockout shall exist for branch ducting supply air.
   e. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

4. Fan:
   a. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
   b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
   c. The airflow rate shall be available in high and low settings.
   d. The fan motor shall be thermally protected.

5. Filter:
   a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

6. Coil:
   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   c. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
   d. The refrigerant connections shall be brazed connections (flare not allowed) and the condensate will be 1 -1/32 inch outside diameter PVC.
   e. A condensate pan shall be located under the coil.
   f. A thermistor will be located on the liquid and gas line.

7. Electrical:
   a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet). Wire type 15/18 AWG, 2-wire, non-polarity, stranded
   c. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

8. Control:

a. The unit shall have controls provided by manufacturer to perform input functions necessary to operate the system.
b. The unit shall be compatible with interfacing with connection to BACNET networks or interfacing with connection to BMS system. Coordinate with Building Automation Provider as to Type. Consult with manufacturer prior to applying controls.

9. Accessories:
   a. Programmable thermostat per indoor unit with locking cover.
   b. Provide unit mounted integral condensate pump accessory powered by the unit.

B. CEILING/WALL MOUNTED UNIT

1. General: Indoor unit shall be a ceiling or wall mounted fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature. A mildew-proof, air filter and condensate drain pan shall be included as standard equipment. The indoor units sound pressure shall not exceed 35 dB(A) at low speed measured at 3.3 feet below and from the unit.
2. Performance: Each unit's performance is based on nominal operating conditions:
3. Indoor Unit:
   a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, brazed connections (flared not allowed), condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
   b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
   c. Both refrigerant lines shall be insulated from the outdoor unit.
   d. Return air shall be through a mold resistant filter.
   e. The indoor units shall be equipped with a condensate pan.
   f. The indoor units shall be equipped with a return air thermistor.
   g. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
   h. The voltage range will be 253 volts maximum and 187 volts minimum.

4. Unit Cabinet:
   a. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
   b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

5. Fan:

a. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.054 to 0.058 HP.
c. The airflow rate shall be available in high and low settings.
d. The fan motor shall be thermally protected.

6. Coil:
   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
   c. The coil shall be a 2-row cross fin copper evaporator coil with 14 fpi design completely factory tested.
   d. The refrigerant connections shall be brazed connections (flare not allowed) and the condensate will be 11/16 inch outside diameter PVC.
   e. A thermistor will be located on the liquid and gas line.
   f. A condensate pan shall be located in the unit.

7. Electrical:
   a. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
   b. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
   c. Transmission (control) wiring between the indoor and remote controller shall be a maximum distance of 1,640 feet.

8. Control:
   a. The unit shall have controls provided by manufacturer to perform input functions necessary to operate the system.
   b. The unit shall be compatible with interfacing with connection to LonWorks networks or interfacing with connection to BMS system. Coordinate with Building Automation Provider as to type. Consult with manufacturer prior to applying controls.

9. Accessories Available:
   a. Remote “in-room” sensor kit
   b. BAS-integrated Temperature Sensor per indoor unit.
   c. Provide unit mounted integral condensate pump accessory powered by the unit.
   d. Provide condensate overflow sensor wired to shutdown the terminal unit and alarm to the BAS. Sensor shall fully comply with most current version of IMC / CBC for units producing condensate above ceilings.

C. ACCESSORIES:

10. Condensate Pump; each Unit (ZB or IU) with a condensate drain connection shall have a condensate pump provided by the manufacturer if available, or provided by the contractor (in accordance with spec 232123) when the VRV manufacturer does not offer this as an option. Each condensate pump shall have safeties to alarm to the BAS when pump is not working, and automatically shut down the IU/ZB.

11. Equipment designation / Label. Each IU and ZB, and ACCU shall have a consistent label in the field with the BAS label. Label shall indicate [ACCU#]-[ZB#]-[IU#]-[Room#]. All equipment numbers shall be unique.

## 2.3 OUTDOOR UNIT

A. General: The outdoor unit is designed specifically for use with VRV series components.
1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receivers and accumulators. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
2. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
3. Each outdoor system shall be able to support the connection of up to 64 indoor units dependent on the model of the outdoor unit.
4. The sound pressure level standard shall be that value as listed in the manufacturer engineering manual for the specified models at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
5. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
6. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
7. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
8. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.
9. Oil Return Heating – Multiple condenser VRV systems shall maintain continuous heating during oil return operation. Reverse cycle (cooling mode) oil return during heating operation shall not be permitted due to the potential reduction in space temperature.
10. Oil recovery cycle shall be automatically according to manufacturer specific requirements to have a regularly occurring oil recovery cycle, or an oil management system. Scheduled oil recovery cycles shall occur 2 hours after start of operation and then every 8 hours of operation. Each system shall maintain continuous heating during oil return operation.
11. The outdoor unit shall be capable of heating operation at -20°F dry bulb ambient temperature. Provide all accessories as needed including but not limited to wind baffles, oversized accumulator, VFDs for fans, and heat tracing.

B. Unit Cabinet:
1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:

1. The condensing unit shall consist of one or more propeller type, direct-drive 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.24 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 7,400 CFM.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
6. The outdoor unit shall be capable of operating at further reduced sound levels during night time.

D. Condenser Coil:
1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

E. Compressor:
1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors or digital scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator. High/low pressure gas line, liquid and suction lines must be individually insulated between the condensing and indoor units.
2. The inverter scroll compressors shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
3. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “F-type” with a maximum speed of 6,480 rpm.
4. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.

5. The capacity control range shall be 7% to 100%.
6. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
7. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
8. Oil separators shall be standard with the equipment together with an intelligent oil management system.
9. The compressor shall be spring mounted to avoid the transmission of vibration.
10. Units sized 12-20 ton units shall contain a minimum of 2 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.
11. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle or every 8 hours.

F. Refrigerant Piping
1. The system shall be capable of refrigerant piping up to 540 actual feet or 620 equivalent feet from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280 feet of piping between the condensing and indoor units with 295 feet maximum vertical difference, without any oil traps.
2. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.
3. Refrigerant piping shall be insulated with a minimum of ¾" EPDM insulation capable of withstanding a minimum temperature of 250 deg F.
4. Expansion loops shall be accounted for in piping lengths

G. Electrical:
1. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the wiring operation.

2.4 VRV FEATURES:

A. Advanced Zoning – A single system shall provide for up to 24 zones.

B. Independent Control – Each fan coil shall use a dedicated electronic expansion valve for independent control.

C. VFD Inverter Control – Each condensing unit shall use a high efficiency, variable speed "inverter" compressor coupled with inverter fan motors for superior part load performance. Compressor capacity shall be modulated automatically to maintain a constant suction pressure, while varying the refrigerant volume for the needs of the cooling or heating loads. Indoor fan coil units shall use PID control to control superheat to deliver a comfortable room temperature condition.

D. Flexible Design – Systems shall be capable of up to 492ft (575ft equivalent) of linear piping between the condensing unit and furthest located fan coil unit. Systems shall be capable of up to 1,000ft total "one-way" piping in the piping network. Systems shall have a vertical (height) separation of up to 165ft between the condensing unit and the fan coil units. Condensing units

shall be supported with a fan/fan motor ESP up to 0.24" WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.

E. Simple Wiring – Systems shall use 2 wire, multi-stranded, non-shielded and non-polarized daisy chain control wiring.

F. Advanced Diagnostics – Systems shall include a self diagnostic, auto-check function to detect a malfunction and display the type and location.

G. Advanced Controls –Each system shall be capable of integrating with open protocol BACnet and LONworks building management systems.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. System must be installed by factory trained contractor

B. Coordinate and verify in field to maintain all manufacturer's recommended clearances.

C. Install units level and plumb.

D. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

E. Install roof-mounted, compressor-condenser components on equipment rails (height as recommended by manufacturer to prevent ice buildup during winter operation, but not less than 24" above roof surface). All exposed metal framing/rails/components shall be galvanized.

F. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. See Division 23 Section

G. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION**

**SECTION 23 74 16.13**

**PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of Division 22, 23 and 26 apply to this section.

### 1.2 SUMMARY

A. Section includes packaged, large-capacity, rooftop air conditioning units (RTUs) / Make-up Air Handling Units: (MAUs) with the following components and accessories:

1. Casings.
2. Compressors and condenser fans.
3. Motors.
4. Direct-expansion cooling coil.
5. Refrigerant circuit components.
6. Air filtration.
7. Modulating indirect gas-fired heat exchanger.
8. Outdoor - air damper section.
9. Electrical power connections.
10. Integral controls interface to the building automation system
11. Accessories
12. Vibration roof supports (or vibration curb).
13. Airflow measuring stations.

### 1.3 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electronically commutated motor.

C. Condenser Fan: The outdoor-air refrigerant-coil fan in MAU/RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

D. Outdoor-Air Refrigerant Coil (Condenser Coil): Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, large-capacity, rooftop air-conditioning units with DX cooling and either gas heating, electric-resistance heating. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

F. MAU: Make-up Air handling Unit. As used in this Section, this abbreviation means packaged, large-capacity, rooftop air-conditioning units with DX cooling and either gas heating, electric-resistance heating. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

G. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. Supply-Air Refrigerant Coil (DX Cooling Coil): Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

## 1.4 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each MAU/RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

1. Certified fan performance curves with system operating conditions indicated.
2. Air static pressure drop across all internal components (internal pressure drop per air stream), external pressure drops, total pressure drops.
3. Certified discharge, inlet and radiated sound power ratings.
4. Certified DX cooling coil, compressors and gas furnace performance ratings (ARI conditions and scheduled including unloading) with system.
5. Refrigerant type, number of circuits and pounds of refrigerant per circuit.
6. Motor ratings and electrical characteristics plus motor and fan accessories including total unit MCA sand MOCP.
7. Materials gauges and finishes.
8. Filter performance data.
9. Damper performance data, and descriptions of housings, linkages, and operators.
10. Accessories

B. Controls Data:

1. Provide cut sheets for all field installed control devices.
2. Provide detailed control wiring diagram for all field installed control devices.
3. Provide narrative description of unit sequence of operation specific to the application for which it is intended. A generic sequence of operation describing all possible modes of operation the unit is capable of is not acceptable.
4. Provide full list of unit BACnet points available to the BAS through the protocol interface.

C. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring (differentiating between manufacturer-installed wiring and field-installed wiring).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which MAU/RTUs will be attached.
2. Roof openings.
3. Roof curbs and flashing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MAU/RTUs to include in emergency, operation, and maintenance manuals.

B. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 340/360 for testing and rating energy efficiencies for MAU/RTUs.
2. Comply with ARI 270 for testing and rating sound performance for MAU/RTUs.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested in accordance with AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

C. ASHRAE/IECC Compliance:

1. Comply with ASHRAE 15.
2. Comply with ASHRAE 33.
3. Comply with ASHRAE/IESNA 90.1-2016.
4. Comply with IECC 2018

D. City of Chicago Compliance: Comply with current City of Chicago Code

E. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

F. UL Compliance: Comply with UL 1995.

G. Electrical Components, Devices, and Accessories: In addition to the City of Chicago Code requirements listed above, electrical components, devices, and accessories listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. Motors: Motors shall conform to the latest applicable requirements of NEMA, IEEE, ANSI, and NEC standards.

I. Dampers: Damper leakage rate shall be tested and certified in accordance with the Air Movement and Controls Association (AMCA) standard 500.

J. Delegated-Design Submittal: For MAU/RTU supports/building structural modifications, including analysis data and structural design signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for structural support of the new roof top units on the existing building structure.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set(s) for each belt-driven fan.
2. Filters: Construction filters as required for each unit. One post construction set of filters for each unit.

1.9 DELIVERY, STORAGE AND HANDLING

A. As required / recommended by the manufacturer.

B. Disassemble units as required for movement to the site location. Reassemble major units under direction of manufacturer's representative.

C. Lift and support unit with the manufacturer's designated lifting or supporting points.

1.10 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

B. Coordinate the size and location of roof curbs.

1.11 WARRANTY

A. General Warranty: The entire unit (including parts, labor and refrigerant charge) shall be warranted by the manufacturer against defects in materials and workmanship, and for all

parameters of the unit operation and performance, to include all components for a period of one year after substantial completion.

B. Special Warranty: Manufacturer agrees to repair or replace components of MAU/RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with all project requirements, provide products by one of the following:

1. Daikin
2. AAON
3. JCI/York
4. Trane

### 2.2 CAPACITIES AND CHARACTERISTICS

A. As scheduled on drawings.

### 2.3 PACKAGED FACTORY ASSEMBLED UNITS

A. General:

1. Provide and install packaged rooftop unit(s) including fans, compressors, coils, piping, furnaces, dampers, electrical and DDC controls. Each system shall be factory assembled, piped, internally wired, and fully charged with refrigerant and ready to operate. The systems shall heat, cool, dehumidify and be of the constant volume or variable air volume type as so specified or scheduled on the plans. The units shall be constructed for outdoor installation and configured as shown on the plans.
2. Factory packaged applied rooftop air conditioning system shall be the size indicated and shall contain the components indicated on drawings and described herein. Performance characteristics of all components are the minimum that will be acceptable.
3. Units must be shipped in single piece or major assembled sections to facilitate ease of rigging and installation. Rigging and joining of sections shall be done at the job site.

Field built units and their components will not be accepted. All units shall be inspected and tested at the manufacturer's plant before shipment is made to the jobsite.

B. Motor and Electrical Components: Refer to Division 23 sections.

C. Capacity, size, static pressure, coils, filters, accessories, limiting velocities, arrangement, etc., as shown on Drawings and referred to in appropriate Division 23 Sections.

## 2.4 CASINGS

A. The frame and unit base shall be made of manufacturer's standard gauge painted galvanized steel with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs. The unit shall be provided with an integral structural base that extends the full length of the unit to facilitate curb or post and rail mounting. The unit base channel shall be equipped with lifting lugs for rigging.

B. Exterior surfaces shall be phosphatized and coated with baked-on enamel. Finished surface shall withstand a minimum 500-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance. All sections of the unit shall be provided with full sized, double wall, hinged access doors, constructed of galvanized steel. Access doors shall utilize flush mounted single action lever, staggered engagement latching mechanism, which provides easy access to each cabinet section. Access doors shall be provided on both sides of the unit. Each door shall be equipped with a steel retainer rod to hold the door fully open. All access doors shall open against pressure.

C. Unit shall be completely double wall insulated with foam or glass fiber insulation (including base) with an R-value of 4.0 (minimum) secured to all panels with adhesive. All interior surfaces of the unit shall include solid galvanized liners to form a double wall panel construction.

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

## 2.5 SUPPLY/EXHAUST FANS

A. Supply-Air Fans: Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

1. Direct-Driven Supply-Air Fans: Motor shall be resiliently mounted in the fan inlet.
2. Fans shall be non-overloading, centrifugal airfoil dwdi or plenum type as required to meet the airflow, static pressure and sound requirements. Class II minimum. All fans shall be statically and dynamically balanced for quiet operation. Fan bearings shall be L50 / 200,000 hour.
3. Fan motors shall be heavy-duty, 1800 RPM, open drip-proof type with relubricative ball bearings. The entire fan assembly shall be completely isolated from the unit bulkhead with neoprene gasketing and mounted on spring isolators with thrust restraints.

B. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed or ECM motors as required to meet code energy full load and part load efficiency, minimum capacity and sound requirements.

C. Modulating Relief-Air Fan (Power Exhaust): Propeller or centrifugal with motorized damper, shaft mounted on permanently lubricated motor. Minimum Class II.

D. Fan Motor: VFD duty. Comply with additional requirements in Division 23.

## 2.6 MOTORS

A. Comply with Section 230513 "Common Motor Requirements for HVAC Equipment" and the requirements of this Article.

B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

## 2.7 REFRIGERANT COILS

A. Evaporator coils shall be multi-row interlaced circuiting and fabricated from seamless copper tubing mechanically bonded to rippled and corrugated aluminum fins. Evaporator coils shall have rows & fins as scheduled. Casing shall be stainless steel.

B. Coils shall be factory leak tested at 315 PSIG under water. Each evaporator coil circuit shall be fed with an adjustable thermal expansion valve with an external equalizer.

C. A stainless steel, insulated, positively sloped primary drain pan (ASHRAE 62.1 compliant) shall be provided beneath the cooling coil and extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall be connected to a threaded drain connection extended through the unit base. Units shall be provided with a secondary stainless steel drain (extended under the coil distributor tubes, return bends and refrigeration specialties) connected to the primary drain pan.

## 2.8 OUTSIDE AIR SECTION

A. The outside air section shall be ducted. The floor of the outside air section shall be sloped to the outside of the unit for water drainage. The outside air dampers shall be sized to handle 100% of the supply air volume. Dampers shall be Ultra Seal low leak type with gasketed blade to blade contact and spring side seals. Damper blades shall be hollow core, airfoil type for extra rigidity. Air leakage through the damper section shall be less than two tenths of one percent leakage at 1.5 inches static pressure differential, or 6 CFM/Ft at 4" static pressure differential.

B. Supply Air Airflow Measuring Stations: Provide airflow station and control of the fans such that the MAU/RTU controller to maintain a positive space pressure (+0.05” WC adjustable) relative to ambient. See 230900 for additional air flow station and space / ambient pressure transducer / transmitter / pick up port requirements.

## 2.9 VARIABLE AIR VOLUME CONTROL

A. An electronic variable frequency drive shall be provided for the supply fan(s). Each drive shall be factory installed in a designated access section, downstream of the filters and upstream of the cooling coil, in a manner that the drive(s) are directly cooled by the filtered, mixed air stream. Drives, controls and associated access section shall be safely accessible from outside the rooftop unit such that the drive/controls can be manually manipulated without shutting down the unit or physically entering the airstream Drives shall meet UL Standard 95-5V and the variable frequency drive manufacturer shall have specifically approved them for plenum duty application and City of Chicago Code. The completed unit assembly shall be listed by a recognized safety agency, such as ETL/UL. Drives are to be accessible through a hinged door assembly complete with a single handle latch mechanism. Mounting arrangements that expose drives to high temperature, unfiltered ambient air are not acceptable. The unit manufacturer shall install all power and control wiring. The fan drive outputs shall be independently controlled in order to provide the control needed to maintain building pressure control. The wheel drive outputs shall be independently controlled in conjunction with the wheel bypass dampers in order to provide the control needed to maintain the discharge air temperature setpoint under cooling, heating, economizer and dehumidification operation. Refer to Division 23 Section 230515for additional variable speed drive requirements.

## 2.10 CONDENSING SECTION

A. Compressors shall be high efficiency, heavy-duty, scroll compressors with suction and discharge line service valves, crankcase heater and motor overload protection. Compressors shall be isolated on spring isolators with braided type vibration eliminators in the piping to decrease vibration and noise transmission.

B. Units 20 tons and greater shall have two independent refrigeration circuits minimum. Each refrigeration circuit shall include a liquid line solenoid valve, low pressure control, liquid moisture indicator/sight-glass, replaceable core filter drier, thermal expansion valve, liquid line shutoff valve with charging port, manual reset high pressure safety switch, high pressure relief valve and pump down switch of its rated capacity. No refrigerant circuit regardless of tonnage shall contain more than 90 lbs of refrigerant.

C. Units shall have multiple compressor. Provide capacity reduction from 100% down to 15% complying with scheduled full load and part load efficiency requirements. When not specifically scheduled, acceptable means of capacity control are variable speed or digital scroll or staged scroll compressors with hot gas bypass provided they comply with both project energy targets, project energy code and project sound requirements. Provide sound compressor wraps as required for the entire unit operating at full capacity to meet the more stringent of 55 dba at the lot line (see project site plan and unit locations on drawings) and scheduled sound requirements.

D. The condensing unit section shall be open on the sides and bottom to assure complete access and airflow through the coils. Condenser coils shall be multi-row type fabricated from high efficiency riffled copper tubing mechanically bonded to aluminum fins. Each refrigerant circuit shall include a sub-cooler circuit to provide 15 degrees F of sub liquid sub-cooling. Each condenser shall be factory leak tested under water. Each circuit shall be dehydrated and factory charged with refrigerant and oil.

E. Provide condenser coil guards, constructed of cross wire welded steel, PVC coated. Mount guards to each side of the condensing section to provide protection to the condenser coil.

F. Condenser fans shall be direct drive, propeller type designed for, low tip speed and vertical air discharge. Fan blades shall be constructed of steel and riveted to a steel center hub. Fans shall be variable speed or staged to maintain head pressure control down to 45F ambient. Fan type / control shall comply with both project energy and sound requirements. Assembled unit sound operating at full capacity shall meet the more stringent of 55 dba at the lot line (see project site plan and unit locations on drawings) and scheduled sound requirements.

G. Condenser fan motors shall be heavy-duty, inherently protected three-phase non-reversing type with permanently lubricated ball bearing and integral rain shield. Electronically commutated motors shall be provided as required to comply with full and part load energy requirements.

H. Hot-Gas Reheat Refrigerant Coil:

1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.

I. An ambient thermostat shall prevent the refrigeration system from operating below 45 degree F.

J. Refrigeration Specialties:

1. Refrigerant Charge: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Hot-gas reheat solenoid valve with a replaceable magnetic coil.

## 2.11 ELECTRIC REHEAT (WHEN SCHEDULED)

A. Electric heating coils shall be located in the reheat position and be constructed with low watt density nickel chromium elements. Safety controls shall include automatic reset high limit control for each heater element in the discharge air stream of each heater bank, and line break protection in each heater circuit. Heating element branch circuits shall be individually fused to a maximum of 48 amps to meet NEC requirements.

B. A microprocessor based DDC control system with full magnetic line break contactors shall provide modulating temperature control. The electric heating section shall contain a single point electrical connection with a factory mounted non-fused disconnect switch to provide power to the unit as well as the electric heat section.

2.12 AIR FILTRATION

A. The filter sections shall be supplied complete with galvanized steel filter racks as an integral part of the unit. Filters shall be accessible from both sides of the unit.

B. Provide 2-inch thick MERV 8 pleated pre-filters in the outside air stream mounted in a galvanized steel filter frame.

C. Provide 4-inch thick MERV 13 pleated final-filters in the mixed air stream downstream of the pre-filters mounted in a galvanized steel filter frame.

D. Provide filter differential pressure gauges across each filter.

E. Provide dirty filter switch / alarm for building automation system interface across each bank of filters.

F. Filters shall comply with ASHARE 52.2.

2.13 GAS HEAT

A. A natural gas fired furnace (80% efficient) shall be installed in the unit heat section. The heat exchanger shall include a type 430 stainless steel cylindrical primary combustion chamber, a type 430 stainless steel header, type 430 stainless steel secondary tubes and type 430 stainless steel turbulators. The heat exchanger shall have a condensate drain and stainless steel drain pan beneath unit. Clean out of the primary heat exchanger and secondary tubes shall be accomplished without removing casing panels or passing soot through the supply air passages. The furnace section shall be positioned downstream of the supply air fan.

B. The furnace will be supplied with a modulating forced draft burner capable of continuous modulation between 5% and 100% of rated capacity, without steps. The burner shall operate efficiently at all firing rates. The burner shall have proven open damper low-high-low pre-purge cycle, and proven low fire start. The combustion air control damper shall be in the closed position during the off cycle to reduce losses. The burner shall be rated for operation and full modulation capability at inlet gas pressures down to 7.0 in. W.C. The shutoff cock and test cock shall be fully ported ball valves.

C. The burner shall be specifically designed to burn natural gas and shall include a microprocessor based flame safeguard control, combustion air proving switch, pre-purge timer and spark ignition. The gas train shall include redundant gas valves, shutoff cock, pilot gas valve, pilot pressure regulator, and pilot cock. The gas train shall be FM or IRI rated.

D. The gas burner shall be controlled by the factory installed main unit control system.

2.14 ELECTRICAL POWER CONNECTIONS

A. Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with NEC requirements and shall conform with all applicable UL standards and the City of Chicago Code. All electrical components shall be labeled according to the electrical diagram and be UL recognized where applicable. Each unit shall have a 115 volt control circuit transformer, 115

volt receptacle with separate electrical connection and lights within all sections wired to a separate electrical connection and weather proof switch on the exterior of the unit.

B. The supply air fan, lights, compressor and condenser fan motor branch circuits shall be individually fused. Contactors and inherent thermal overload protection. Shall be furnished for each compressor and condenser fan motor. The supply fan motors shall have contactors and external overload protection. The unit shall include a weatherproof main control panel and mounted within a weatherproof construction with a dead front cover over main power circuit control. A single point through the door non-fused disconnect shall be provided for the main power connection and a terminal board shall be provided for low voltage control wiring. Knockouts shall be provided in the he bottom of the main control panels for field wiring entrance. A separate key locked control panel shall house all controls for the condensing section.

C. Phase failure and under voltage protection on three-phase motors shall be provided to prevent damage from single phasing, phase reversal, and low voltage conditions.

## 2.15 DDC MICROPROCESSOR CONTROLS

A. General - Each unit shall be provided with a factory-installed, programmed and run-tested, stand-alone, microprocessor control system. This system shall consist of temperature and pressure (thermistor and transducer) sensors, printed circuit boards, and a unit-mounted Human Interface Panel. The microprocessor shall be equipped with on-board diagnostics to indicate that all hardware, software, and all interconnected wiring and sensors are in proper operating condition. The microprocessor's memory shall be non-volatile EEPROM type, thus requiring no battery or capacitive backup to maintain all data during a power loss.

B. Internal Controls – The MAU/RTU internal microprocessor controls shall manage the operation of the supply fan, direct expansion cooling, hot gas reheat coil (dehumidification cycle), indirect gas-fired heating, relief/exhaust fan and the outside air dampers modulation. The rooftop unit shall be commanded from the building automation system (BAS) through a BACnet protocol interface to operate in occupied or unoccupied mode. The BAS will provide setpoint information to the MAU/RTU controller. The MAU/RTU will provide alarm and other feedback information to the BAS. See sequence of operation details below for specific information on the operation of the individual MAU/RTUs.

C. Protocol Interface – Provide a bacnet protocol interface between the rooftop units and the BAS. Provide hardwire interface between the BAS and the rooftop unit to accomplish the sequence of operation.

D. Anti-Recycle Protection – Anti-recycle protection shall be provided to prevent excessive cycling, and premature wear, of the compressors, contactors and related components.

E. Economizer Damper Controls – The MAU/RTU shall internally control the modulation of the OA, RA, and EA dampers. The dampers shall provide full economizer operation when conditions allow for free cooling. In addition, provide all controls including sensors for a fully functional Economizer Fault Detection and Diagnostic system complying with IECC2018 with output to the BAS.

F. Refrigerant Circuit Operation – On internal staged command for cooling, the MAU/RTU shall internally control the staging of compressors and/or unloaders to maintain DAT setpoint. Condenser fans shall cycle to maintain proper operating refrigerant pressures.

G. Gas Furnace Operation – Stages and modulation of gas heating shall be controlled by MAU/RTU internal controls to provide morning warm up heating, night setback heating, and occupied heating to maintain DAT setpoint.

H. Smoke Detectors Safeties – Provide smoke detectors for supply ducts. Smoke detectors shall either be factory installed in rooftop unit or provided for field installation in supply ductwork. Detectors shall be hard wired to shut down the fans and close the outside air and exhaust air dampers. Additional dry contacts shall be provided for the BAS and fire alarm.

## 2.16 AIRFLOW MEASURING STATIONS

A. See schedule notes and temperature control drawings for quantities and locations. See 230900 for material specification requirements. Airflow stations to be factory mounted.

## 2.17 SEQUENCE OF OPERATION

A. RTUs and MAUs shall be fully integrated into the BAS through a BACnet protocol interface. See drawings schedules for additional temperature controls requirements and sequences.

## 2.18 ACCESSORIES

A. Filter differential pressure switch with sensor tubing on either side of each filter bank. Set for final filter pressure loss.

B. Coil guards of painted, galvanized-steel wire.

C. Supply smoke detectors hard wired to associated fan with dry contacts for fire alarm and building automation connections.

D. Building space pressure sensor/transducer.

E. Building space humidity sensor.

F. Mixed air temperature sensor.

G. Separate cooling coil, hot gas reheat coil, and furnace discharge temperature sensors.

H. Supply duct static pressure sensor.

I. Exhaust duct static pressure sensor.

J. Central space temperature sensor for night setback / setup.

K. Fan static pressure cutouts (Hi and Low). Provide for each fan wired to the fan starter and alarm to the building automation system.

L. Safety Control Operation:

1. Smoke Detectors: Stop fans and close OA/EA dampers if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.

M. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.

N. Vertical vent extensions to increase the separation between the outdoor-air intake and the flue-gas outlet.

O. Outdoor air intake weather hood with moisture eliminator.

2.19 VIBRATION ISOLATION

A. Provide roof curbs with vibration isolators, or separate vibration isolation base and rail when unit is mounted on steel directly (minimum 2" deflection).

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C 1071, Type I or II.
b. R-value: 10

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C 916, Type I.
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of MAU/RTUs.

B. Examine roughing-in for RTUs/MAUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where MAU/RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Secure MAU/RTUs to structure / upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Unit Support: Install unit level on structural curbs or steel supports. Coordinate wall penetrations and flashing with wall construction. Secure MAU/RTUs to structural support with anchor bolts.

C. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."

## 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

B. Connection condensate drain pans using 1-1/4-inch, Type M copper tubing. Extend to the nearest roof drain or area drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

C. Arrange piping installation adjacent to MAU/RTUs to allow service and maintenance.

1. Connection piping to applied rooftop units with flexible connectors.

2. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

D. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb. Seal openings in roof deck to supply and return air plenums to same leakage at pressure rating as curb.
3. Connect supply ducts to MAU/RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified with concrete.

E. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs as specified in Section 260553 "Identification for Electrical Systems."
2. Locate nameplate where easily visible.

## 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform the following tests and inspections:

1. After installing RTUs/MAUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. MAU/RTU will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.5 ADJUSTING, CLEANING AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet and coils entering air face.

## 3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork and electrical are complete. Verify proper thermal overload protection is installed in motors, starter, and disconnects.

C. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts and install belt guards.

D. Lubricate bearings, pulleys, belts and other moving parts with factory recommended lubricants.

E. Comb coil fins for parallel orientation.

F. Install clean filters.

G. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the full-open position.

H. Disable automatic temperature control operators.

I. Complete installation and startup checks according to manufacturer's written instructions.

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of dampers (both motorized and barometric relief dampers when provided).
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.

    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Calibrate thermostats / sensors and controls.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air and exhaust air dampers for proper stroke and controls.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above outside-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply-air volume / Outdoor-air intake volume.

27. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

## 3.7 POST OCCUPANCY ADJUSTMENT

A. Occupancy Adjustments: When requested within 12 months from date of Preliminary Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions.

B. After completing system installation and testing, adjusting, and balancing MAU/RTU and air-distribution systems, clean filter housings and install new filters.

## 3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the roof top units as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting up, adjusting, operating and shutting down, troubleshooting, servicing, and maintaining the equipment. The training will occur after the startup report has been provided to the owner and the trainer will provide four Installation and Operation manuals for the use of the Owner's personnel during training.
2. Review data in maintenance manuals. Refer to Division 01 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data." All required and recommended maintenance will be reviewed as well as operational troubleshooting. If the IOM does not include a written troubleshooting guide, one will be provided.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.
5. Training will occur in two (2) separate eight (8) hour sessions, neither on the same day nor on a day that the roof top units are started up.

B. Demonstrate proper operation of equipment to commissioning agent or designated Owner's personnel. The scope of the demonstration shall include functional performance requirements under both local and building automation control as well as any commissioning requirements in Division 01 and 23.

C. Video record the training sessions. The manufacturer may submit a standard training video training CD for review as an alternate to videotaping of the training session. The standard video must be reviewed and accepted by the owner/commissioning authority for the alternate to be acceptable.

**END OF SECTION**

**SECTION 23 82 19**

**FAN COIL UNITS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. All sections of Division 23 and 26 apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Fan coil units and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, fan curves, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of fan coil unit indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate FCU and pipe details as part of the Hydronic pipe coordination drawings. Refer to Spec 232113.

B. Factory Color Chart: Unit color to be selected from standard factory colors by architect. Units directly exposed to view in public areas shall have custom colors selected by architect.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Field quality-control reports.

B. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Coil Unit Filters: Furnish filters during construction and one post construction spare filters for each filter installed.
2. Fan Belts: Furnish one spare fan belts for each unit installed that utilizes fan belts..

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 DELIVERY, STORAGE AND HANDLING

A. Units shall be stored and handled in accordance with manufacturer’s instructions.

B. Protect units from damage and construction debris before installation. Cover open pipe ends during shipping and storage at the construction site.

1.9 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.10 WARRANTY

A. Written manufacturer's warranty covering parts and labor for a period of one year from preliminary acceptance, or eighteen months from shipment, whichever is longer.

**PART 2 - PRODUCTS**

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 FAN COIL UNITS

A. Subject to compliance with requirements, provide diffusers by one of the following:

1. International Environmental Corporation (IEC).
2. Daikin.
3. Williams
4. Krueger
5. Johnson Controls (YORK International Corporation).
6. Whalen
7. Trane

B. Coil Section Insulation: 1/2-inch- thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Main and Auxiliary Drain Pans: Insulated Stainless steel formed to sloped from all directions to the drain connections to comply with ASHRAE 62.1. Provide float switch accessory interlocked to shutdown fan coil in drain pan overflow condition.

D. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

E. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

1. Vertical Unit Front Panels: Removable, steel, with steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
2. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from

manufacturer's custom colors. See plans for supply and return grille orientation. Provide multiple supply grilles when multiple supply airflow directions are shown on plans. Return grille shall provide maintenance access to fan coil unit. Stack type unit cabinet shall be design for use with drywall attached to enclosure.

3. Steel recessing flanges for recessing fan coil units into ceiling or wall.
4. Insulate seal / provide UL fire enclosure system to maintain wall / floor / ceiling sound and fire ratings. See architectural for requirements.

F. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
   1. Glass Fiber Treated with Adhesive: 80 percent arrestance and MERV 7.

G. Hydronic Coils (where scheduled): Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

H. Electric-Resistance Heating Coils (where scheduled): Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

I. Fan and Motor Board: Removable.

   1. Fan: Direct drive, centrifugal; directly connected to motor. Aluminum or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.

   1. Motor: Electronically Commutated Motors (ECM) with three speed (low, medium, high setting). Performance selections shall be based on scheduled speed to achieve full schedule design capacity without exceeding sound limits. Fan speed setpoints shall be field adjustable (Adjust during test and balance to optimize comfort and sound).
   2. Wiring Termination: Connect motor to chassis wiring with plug connection.

J. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

   1. Two-way, two-position control valve (minimum 50 psig close off pressure). Actuators shall be rated for max airstream temperatures. See schedule for chilled water, hot water, dual temperature application.

   2. Two-Piece Ball Valves (supply / return): Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
   3. Automatic Flow-Control Balance Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig. Provide integral pressure and temperature taps to allow for field verification of pressure differential across valve.
   4. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and

bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.

5. Risers: ASTM B 88, Type L copper pipe with hose and ball valve for system flushing. Type L or M copper pipe for air conditioning condensate pipe. ½" thick factory installed closed cell insulation with vapor barrier on supply / return / condensate. Provide field installation of riser pipes where required by building construction. Fire-Hazard Classification: insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   a. Refer to plans and schedules.

K. Provide toggle type or door-interlocked disconnect switch.

L. Provide condensate pump accessory. Pumps may be omitted where condensate drain by gravity can be achieved by sloping pipes with approval of engineer of record.

M. Stand Alone Unit Controls:

1. Control voltage transformer.
2. Field mounted thermostat with the following features:

   a. 7-day programmable thermostat (Min M-F 4 settings per day, Sat 4 settings, Sun 4 settings. Setpoint override with timed revert back to schedule).
   b. Digital display (time, day, setpoint, heat, aux heat, cool, auto, on/off, fan speed)
   c. Provide temperature lock out feature allowing the owner to limit the max heating and minimum cooling setpoints.
   d. Heat-cool-auto-off.
   e. Fan low-medium-high-auto-off.
   f. Automatic changeover with sensor on/in riser.
   g. Degree F indication.
   h. Tamper / vandal proof locking cover (protection and prevent setting adjustment) in public occupancy locations.
   i. See schedule / plans for thermostat mounting (remote verses unit) locations.
   j. Auto mode: Upon a call for heating or cooling, the unit senses fan coil riser fluid temperature. If fluid temperature matches setpoint calling (heating hot water = heating, chilled water = cooling), control valve opens, and fan modulates between low-medium-high fan speed settings to achieve setpoint. Once setpoint is achieved, valve closes and fan cycles off. If there is a call for heating and hot water is not available, enable the auxiliary electric heat and modulate fan between low-medium-high fan speed settings to achieve setpoint. Once setpoint is achieved, disable aux electric heat and cycle fan off. Low-medium-high fan speeds shall be set in the field to comfort and sound.
   k. Manual cool mode: User selects cooling and fan speed. In cooling if chilled water is sensed, valve opens, and fan operates to maintain setpoint. Once achieved, valve closes and fan cycles off.
   l. Manual heating mode: User selects heating and fan speed. In heating if hot water is sensed valve opens, if not electric heat is enabled. Fan operates to achieve setpoint. Once achieved, valve closes or electric heat is disabled, and fan cycles off. Hot water and electric heat shall not operate together.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation..

D. Install new filters in each fan coil unit within two weeks after preliminary acceptance.

E. Insulate / seal / provide UL fire closure system to maintain wall/floor/ceiling sound and fire ratings. See architectural for requirements.

F. Design and provide guides, anchors and expansion compensation devices for fan coil risers and piping.

G. Provide air conditioning condensate pump accessory in units in which gravity drainage of condensate cannot be achieved. Provide power from fan coil.

H. Coordinate with owner setpoints / schedules and program all fan coil stand-alone programmable thermostats.

### 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose. Refer to plans and schedules.
3. Where drawings/details do not indicate piping arrangement, provide:

    a. Hydronic units (per coil): Supply side – aqua stat (on riser, provide access), isolation valve, p&t tap, y-strainer with blow down valve and hose cap, manual air vent, control valve with actuator and coil connection. Return side – isolation valve, p&t, autoflow balance valve, p&t, manual air vent and coil connection.

4. Connect condensate drain to indirect waste (nearest floor drain, open site drain, condensate riser).

    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Provide all supply and return grilles.
1. Coordinate sizes and locations on discharge air plenum.

D. Provide unit temperature controls. Coordinate with building automation system.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## 3.4 CLEANING

A. Clean fan-coil units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

C. Clean exterior prior to transfer to Owner.

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
4. Program fan coil ECM motors to design airflows, low/medium/high rates (see schedule). Where full modulation is called for adjust minimum and maximum airflows to with 0 to 10 volt speed signal requirements for interface to building automation system. Final speed adjustments in field to optimize comfort and sound.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.6 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

**END OF SECTION**

**SECTION 23 82 36**

**FINNED-TUBE RADIATION HEATERS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. All sections of Divisions 23 and 26 apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Hydronic finned-tube radiators.

1.3 DEFINITIONS – NOT APPLICABLE

1.4 SUBMITTALS: Provide product data and shop drawings as one package (A&B) listed below. Coordination drawings (C below) is part of hydronic pipe coordination drawings submittal.

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Details of custom-fabricated enclosures indicating dimensions.
3. Location and size of each field connection.
4. Location and arrangement of piping valves and specialties.
5. Location and arrangement of integral controls.
6. Enclosure joints, corner pieces, access doors, and other accessories.
7. Wiring Diagrams: Power, signal, and control wiring.
8. Color Samples for Initial Selection: For units with factory-applied color finishes.
9. Color Samples for Verification: For each type of exposed finish required.

C. Coordination Drawings: Indicate Fin tube on hydronic pipe coordination drawings. Refer to spec 232113. Provide plans and other details, drawn to scale, on which the

following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members, including wall construction, to which convection units will be attached.
2. Method of attaching convection units to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

D. Operation and Maintenance Data (with close-out documents): For convection heating units to include in emergency, operation, and maintenance manuals. Field quality control reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 DELIVERY, STORAGE AND HANDLING

A. Follow manufacturer's instructions for job site storage and protection of materials during construction.

1.7 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of substantial completion, whichever is longer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Hot-Water Finned-Tube Radiators

a. Dunham-Bush
b. Edwards Engineering Corporation
c. Mestek, Inc., Sterling Radiator Division.
d. Vulcan Radiator Company.
e. Rittling.
f. Runtal

2.2 HOT-WATER FINNED-TUBE RADIATORS

A. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

B. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One tube end shall be belled.

C. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

D. Covers: Provide security covers with minimum 18-gauge cold-rolled steel full backplate, minimum 14-gauge front. Brace end reinforce minimum of 4'-0: o.c. without visible fasteners. Covers shall be wall to wall. No piping or trim shall be exposed to view. Provide all joint covers and end caps for covers.

E. Wall-Mounting Back Panel: Minimum 0.0329-inch thick steel, full height, with full-length channel support for front panel without exposed fasteners.

F. Floor-Mounting Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.

G. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

H. Finish: Flat black heat resisting paint for backplate; factory finished baked enamel, standard colors, on front and accessories.

I. Damper: Knob-operated internal damper at enclosure outlet.

J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

K. Enclosure Style: Flat top.

L. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before convection heating unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 FINNED-TUBE RADIATOR INSTALLATION

A. Install units level and plumb.

B. Install finned-tube radiators according to Guide 2000 - Residential Hydronic Heating.

C. Install enclosure continuously around corners, using outside and inside corner fittings.

D. Join sections with splice plates and filler pieces to provide continuous enclosure.

E. Install access doors for access to valves and thermostats.

F. Install enclosure continuously from wall to wall. No piping / trim shall be exposed to view.

G. Terminate enclosures with manufacturer's end caps, except where enclosures are indicated to extend to adjoining walls.

H. Install valves within reach of access door provided in enclosure.

I. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.

J. Install piping within pedestals for freestanding units.

## 3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties. See drawings for additional requirements.

B. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping."

1. Install shutoff valves, strainer, manual air vent on inlet and outlet, and balancing valve on outlet. Where multiple elements in parallel, provide balancing valve at each outlet. Control valves where noted on drawings. See project drawings/details for additional requirements.
2. Locate trim/control components within enclosure such that ladders are not requirement for maintenance where possible.

C. Install control valves as required by Division 23 Section "Building Automation System."

D. Install piping adjacent to convection heating units to allow service and maintenance.

3.4 DEMONSTRATION – NOT APPLICABLE

3.5 CLEANING

A. Examine and clean inner tubes and exterior fins before installing heating elements.

B. Clean finned tube enclosures after installation.

3.6 CONTRACTOR STARTUP AND REPORTING

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

3.7 DEMONSTRATION AND COMMISSIONING

A. Not applicable.

**END OF SECTION**

**SECTION 23 82 39.13**

**CABINET UNIT HEATERS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 23 and 26 apply to this section.

1.2 SUMMARY

A. This Section includes cabinet unit heaters with centrifugal fans and hot-water, steam and electric-resistance heating coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

1. Perimeter moldings for exposed or partially exposed cabinets.
2. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
3. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

B. Shop Drawings: Provide detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Location and arrangement of piping valves and specialties.
4. Location and arrangement of integral controls.
5. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Provide location of equipment on hydronic pipe drawings: Refer to spec 232113. Floor plans, reflected ceiling plans, and other details, drawn to

scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

D. Operation and Maintenance Data: For cabinet unit heaters to include in operation and maintenance manuals. Field quality control test reports.

## 1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

## 1.6 DELIVERY, STORAGE AND HANDLING

A. Follow manufacturer's instructions for job site storage and protection of materials during construction.

## 1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish one spare filter.

## 1.8 WARRANTY

A. Written manufacturers' warranty covering parts and labor for a period of one year from substantial completion, or eighteen months from shipment, whichever is longer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Hot Water Units:

a. Airtherm; a Mestek Company.
b. Dunham-Bush, Inc.
c. Engineered Air Ltd.
d. International Environmental Corporation.
e. Vulcan Radiator.
f. Rittling

2. Electric Units:

a. Chromalox, Inc.; a division of Emerson Electric Company.
b. Indeeco.
c. Marley Electric Heating; a division of Marley Engineered Products.
d. Rittling.

2.2 CABINET UNIT HEATERS

A. Description: A factory-assembled and -tested unit complying with ARI 440.

1. Comply with UL 2021.

B. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be aluminum-foil facing to prevent erosion of glass fibers.

1. Thickness: 1 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.

C. Cabinet: Steel with factory prime coating, ready for field painting.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0677-inch thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0677-inch thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessing Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.

5. Base: Minimum 0.0528-inch thick steel, finished to match cabinet, 6 inches high with leveling bolts.
6. Extended Piping Compartment: 8-inch wider piping end pocket.

D. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: 90 percent arrestance and 7 MERV.

E. Hot-Water Coil: Seamless copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain. Provide same-end connections for supply and return.

F. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide. Insulating refractory; and sealed in a high-mass steel or corrosion-resistant metallic sheath with fins a minimum of 0.16 inch apart. Provide fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware. Fin surface temperature shall not exceed 550 deg. F at any point during normal operation.

G. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width centrifugal; directly connected to motor. Provide thermoplastic or painted-steel wheels and galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Motors."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

H. Control devices and operational sequences are specified in Division 23 Sections "HVAC Building Automation System" and "Sequence of Operation."

I. Basic Unit Controls:

1. Control voltage transformer.
2. Timer switch.
3. Safety-switch disconnect on cover of terminal box.
4. Mercury contactors.
5. Fan-delay relay.
6. 2 position solenoid valve (spring return, 75 psig close off pressure)
7. Aquastat with adjustable setpoint interlocked with fan.
8. Wall mounted 7 day programmable thermostat (stand alone) with the following features.

a. Heat-off switch.
b. Fan on-auto switch.
c. Manual fan speed switch.
d. Adjustable deadband.
e. Exposed set point.
f. Exposed indication.
g. Deg F indication.

h. Vandal proof locking cover.

J. Electrical Connection: Factory wire motors and controls for a single field connection.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before cabinet unit heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof.

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Mechanical Vibration and Seismic Controls."

D. Install new filters in each unit within two weeks of Substantial Completion.

E. Install separate thermostats 5’ above finished floor.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Duct Accessories."

E. Comply with safety requirements in UL 1995.

F. Ground equipment according to Division 26 Section "Grounding and Bonding."

G. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 CLEANING

A. After construction and painting are completed, clean all exposed surfaces and vacuum interiors.

B. Retouch marred or scratched surfaces of cabinets. If units have factory-finished cabinets, use materials furnished by the manufacturer.

3.5 CONTRACTOR STARTUP AND REPORTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.6 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 1 Section "Demonstration and Training."

**END OF SECTION**

**SECTION 23 82 39.16**

**PROPELLER UNIT HEATERS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

B. All sections of Division 23 and 26 apply to this section.

### 1.2 SUMMARY

A. This Section includes propeller unit heaters with hot-water and electric-resistance coils.

### 1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each unit type and configuration.

B. Shop Drawings: Submit the following for each unit type and configuration:

1. Plans, elevations, sections, and details.
2. Details of anchorages and attachments to structure and to supported equipment.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.

C. Operation and Maintenance Data (with close-out documents): For propeller unit heaters to include in emergency, operation, and maintenance manuals. Field quality control test reports.

### 1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

### 1.5 DELIVERY, STORAGE HANDLING

A. Deliver equipment as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 WARRANTY

A. Warranty: Provide Manufacturer's standard form in which manufacturer agrees to repair or replace components of unit heater that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 year(s) from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Hot Water Unit Heaters:

a. Airtherm; a Mestek Company.
b. Dunham-Bush, Inc.
c. Modine Manufacturing Co.
d. Sterling Radiator
e. Vulcan.
f. Rittling.

2.2 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.

B. Comply with UL 2021.

2.3 CASING

A. Cabinet: Removable panels for maintenance access to controls.

B. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.4 COILS

A. Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.

B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

2.5 FAN

A. Propeller type, aluminum wheel directly mounted on motor shaft in the fan venturi.

2.6 FAN MOTORS

A. Comply with requirements in Division 23 Section "Motors."

2.7 CONTROLS

A. Control Devices:

1. Refer to schedule, if not indicated on schedule: Remote mounted 7 day programmable thermostat.
2. Aquastat wired to unit fan / thermostat to prove hot water available prior to operating.
3. 2 postion hot water solenoid valve (spring return, minimum 75 psig close off pressure).

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before propeller unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters level and plumb.

B. Install propeller unit heaters to comply with NFPA 90A.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers with vertical-limit stop. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports." Vibration hangers are specified in Division 23 Section "Mechanical Vibration and Seismic Controls."

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

E. Install aquastat on hot water branch with continuous flow. Wire to unit. See division 26 for wiring requirements.

F. Install solenoid valve. Wire to unit. See division 26 for wiring requirements.

## 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve and solenoid valve on return-water connection of unit heater. Aquastat on supply main with continuous flow. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

## 3.4 CLEANING – NOT APPLICABLE

## 3.5 CONTRACTOR STARTUP AND REPORTING

A. Testing: Perform the following field quality-control testing and report results in writing:

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safeties.

B. Remove and replace malfunctioning units and retest as specified above.

3.6 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters. Refer to Division 1 Section "Demonstration and Training."

**END OF SECTION**

**SECTION 23 83 18**

**RADIANT HEATING PANELS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. All sections of Division 23 and 26 apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Hydronic heating panels.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits

1.4 SUBMITTALS: Provide product data and shop drawings as one package (A&B) listed below. Coordination drawings (C below) is part of hydronic pipe coordination drawings. Submittal.

A. Product Data: Include rated capacities, specialties, and accessories for each product indicated.

1. Perimeter moldings.
2. Color samples for Initial Selection: For units with factory applied color finishes.
3. Samples for Verification: For each type of exposed finish.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and suspension and attachment. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which heaters and suspension systems will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

D. Operation and Maintenance Manuals with field quality-control test reports.

## 1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of terminal units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years. All products are to have catalogue performance data and certified test data.

## 1.6 DELIVERY, STORAGE AND HANDLING

A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.

B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

## 1.7 COORDINATION

A. Coordinate layout and installation of radiant heaters and panels and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

## 1.8 WARRANTY

A. Written manufacturers warranty covering parts and labor for a period of one year from substantial completion, or eighteen months from shipment, whichever is longer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. AIRTECH Radiant Systems; a division of Engineered Air Ltd.
2. Rosemex Products.
3. Airtite.
4. Shalley Radiant Ceiling Co.
5. Steel Ceilings, Inc.
6. Sterling Radiator Co.
7. Aerotech

2.2 HYDRONIC HEATING PANELS

A. Description: The radiant ceiling shall consist of extruded aluminum with copper tubing of 0.504 in. I.D., mechanically attached to the aluminum face plate. The copper tube shall be held in place by an aluminum saddle which extends more than half-way around the diameter for the tube. A non-hardening heat conductive paste shall be placed between the copper tubing and the aluminum face plate. Panels shall weigh no more than 2.15 lb/ft2 when operating. The use of adhesive and/or clips to attach the copper tube to the extrusion will not be acceptable.

B. Refer to the contract drawings for details and dimensions. Panels shall run continuously from wall to wall and specified widths are minimum allowable.

C. Panels: Minimum 0.0336-inch- thick, galvanized-steel sheet.

D. Backing Insulation: Minimum 1-inch thick, mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB with factory-applied jacket.

E. Exposed-Side Panel Finish: As selected by Architect.

F. Factory Piping: ASTM B 88, Type L copper tube with ASME B16.22 wrought-copper fittings and brazed joints. Piping shall be mechanically bonded to panel.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas to receive radiant heating units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for hydronic piping connections to verify actual locations before radiant heating and cooling unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. Install radiant heating units level and plumb.

B. Suspend radiant heaters from structure.

C. Support for Radiant Heating Panels in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each panel. Locate not more than 6 inches from panel corners.
2. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
3. Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support panels independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

D. Verify locations of thermostats or temperature sensors with Drawings and room details before installation. Install devices 60 inch above finished floor.

E. Provide four inches of batt insulation above entire panel.

## 3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.

C. Install piping adjacent to unit to allow service and maintenance.

## 3.4 CLEANING

A. After construction and painting are completed, clean all exposed surfaces and vacuum interiors.

B. Retouch marred or scratched surfaces. If units have factory-finished cabinets, use materials furnished by the manufacturer.

## 3.5 CONTRACTOR STARTUP AND REPORTING

A. Testing: Perform the following field tests and inspections and prepare test reports:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.

B. Remove and replace malfunctioning units and retest as specified above.

C. After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.6 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain radiant heaters and panels. Refer to Division 1 Section "Demonstration and Training.

**END OF SECTION**

**SECTION 26 05 00**

**COMMON WORK RESULTS FOR ELECTRICAL**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Common electrical installation requirements.

B. Related Requirements:

1. Section 08 31 13 “Access Doors and Frames”
2. Section 07 84 13 “Penetration Firestopping”

### 1.3 REFERENCES

A. Chicago Electrical Code, current edition.

B. NECA 1 Standard for Good Workmanship in Electrical Installations

### 1.4 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. To provide connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

1. Coordinate installation and connection to exterior underground and overhead utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

E. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Section 08 31 13 "Access Doors and Frames."

F. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 07 84 13 “Penetration Firestopping.”

## 1.5 COORDINATION DRAWINGS

A. In addition to the preparation and submittal for Shop Drawings for manufactured electrical equipment and materials, prepare and maintain in current status, a complete set of detailed, completely circuited, and dimensioned electrical construction drawings for all electrical work included under the Contract. These drawings shall be made at the Contractor’s expense and may be made on background copy tracings of the Architect’s drawings.

B. Installation drawings shall be made under the direction and supervision of the Contractor and shall show all electrical work inclusive of conduit, wiring, electrical equipment and devices and elevations, points where conduit enters or leaves structural slabs and walls, junction boxes, conduit supports and inserts. The complete electrical distribution system from source or sources up to and including each branch circuit panelboard shall be shown and dimensioned exactly as installed, with all feeders located on plan. Major equipment and apparatus shall be shown to scale and properly located. Drawings shall also show exact locations and depths of underground conduits and ducts and their terminations, as installed.

C. The drawings shall include floor plan and electrical layouts drawn at a scale (or scales) as required under SHOP DRAWINGS. It is intended that construction drawings of each trade be the same scale(s) in order to permit respective plans to be superimposed upon all others of each trade.

D. In addition to the floor plans, the layouts of all congested areas such as mechanical and/or electrical equipment rooms, and all functionally critical areas shall be drawn at a minimum scale of ¼” equal 1’-0”, or with all details of construction shown. The Architect may request additional drawings if in his opinion they are required to properly coordinate the project.

E. All drawings shall be made in AUTOCAD 2010 or higher of the same size and with the same border lines and title blocks as the Architect's drawings, with the Contractor's name added.

F. The Contractor shall be responsible for the coordination of electrical work with the work of all other trades and shall, in preparing the installation drawings, check the work of other trades and shall, in preparing the installation drawings, check the work of other trades (inclusive of that indicated by shop drawings) in order to avoid possible installation conflicts arising therefrom. It shall be understood that the work shown on the construction drawings has been so coordinated. In the event of conflicts or interfaces that cannot be resolved in the field, the Contractor shall request a written clarification from the Architect.

G. The drawings shall indicate the electrical installation exactly as constructed and therefore shall be periodically revised to reflect all changes inclusive of those required by the Architect, those which are or have been found necessary in the field, those which may be suggested by the Architect etc.

H. Initial copy of all drawings with sign off from the General, Mechanical, Plumbing and Fire Protection Contractors, shall be submitted to the Architect for review. These submittals shall not be considered as shop drawings and are not subject to approval unless so requested. It shall be clearly understood that these construction drawings are for installation coordination purposes only and cannot in any way alter the requirements of the Contract. Therefore, the Contract Drawings, Specifications, and authorized revisions thereto, shall remain the only determinants of contract requirements.

I. Upon completion, the initial drawings, and all revised drawings thereafter, shall be dated and certified by the Contractor as having been fully coordinated by him. It shall then be understood that the work shown thereupon is ready for construction.

J. No electrical work shall begin until these drawings (and each revision thereof) are so drawn, and thereafter finally accepted by the Owner.

K. All drawings shall be made in accordance with an approved schedule, prepared by the Contractor, and arranged coincide with actual construction in such a manner as to allow the latter to proceed without delay.

L. If, in the opinion of the Architect, the coordination drawings are in acceptable condition after each has been finally revised and reviewed, the Contractor may submit same as the field record drawings called for elsewhere in the Specifications.

**PART 2 - PRODUCTS – Not Applicable**

**PART 3 - EXECUTION**

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

F. Right of Way: Give to piping systems installed at a required slope.

G. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. The Architect shall control the placement of wall and ceiling mounted electrical devices, fixtures, and outlets. The intent is to aesthetically locate fixtures/outlets by providing rough-in hardware, boxes and/or mounting plates, as required, when stud or furring may not be readily available for direct mounting. When drawing details are not available, consult with Architect's representative for actual placement.
2. Verify all dimensions by field measurements.
3. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-concrete and other structural components, as they are constructed.
4. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
5. Protect all equipment and materials from the elements, dirt and other damage from the time it is removed from the point of storage until final acceptance.
6. No electrical equipment, raceways or other work of any kind shall be covered up or hidden from view before it has been examined and approved. Any unsatisfactory work or materials shall be removed and corrected immediately.
7. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

## 3.2 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances. Do not proceed with installation until unsatisfactory conditions have been corrected.

## 3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 07 84 13 "Penetration Firestopping."

## 3.4 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with the following requirements:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

    a. Uncover Work to provide for installation of ill-timed Work.
    b. Remove and replace defective Work.
    c. Remove and replace Work not conforming to requirements of the Contract Documents.
    d. Remove samples of installed Work as specified for testing.
    e. Upon written instructions from the Architect, uncover and restore Work to provide for Architect's observation of concealed work.

2. Cut, remove, and legally dispose of electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and direct to adjacent areas.
5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
6. Patch finished surfaces and building components using new materials and methods required for the surface and building components being patched.

## 3.5 FIELD QUALITY CONTROL

A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

## 3.6 CLEANING AND PROTECTION

A. On completion of installation, including all systems outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, construction dust, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

**SECTION 26 05 19**

**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Mineral-insulated cable, Type MI, rated 600 V or less.
3. Fire-alarm wire and cable.
4. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 07 84 13 “Penetration Firestopping”
2. Section 26 05 33 “Raceways and Boxes for Electrical Systems”
3. Section 26 05 53 “Identification for Electrical Systems”
4. Section 26 05 44 “Sleeves and Sleeve Seals for Electrical Raceways and Cabling”
5. Section 28 31 11 “Digital Addressable Fire Alarm System”

1.3 REFERENCES

A. ANSI/NEMA WC 70 ICEA S-95-658 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy

B. UL 44 – Thermoset-Insulated Wires and Cables

C. UL 83 – Thermoplastic-Insulated Wires and Cables

D. UL 854 – Service-Entrance Cables

E. UL 1581 – Standard for Electrical Wires, Cables, and Flexible Cords

F. UL 2196-2018/ULC S-139 – Standard for Fire Test for Circuit Integrity of Fire Resistive power, Instrumentation, Control and Data Cables.

G. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

H. ASTM E119 Standard Test method for Fire tests of Building Construction and Materials.

I. UL 1424 UL Standard for Safety Cables for Power-Limited Fire-Alarm Circuits

J. ASTM B3 Standard Specification for Soft or Annealed Copper Wire

K. NECA 1 Standard for Good Workmanship in Electrical Installations

L. NFPA 72 – National Fire Alarm and Signaling Code, 2016 Edition.

1.4 DEFINITIONS

A. NETA ATS – International Electrical Testing Association, Acceptance Testing Specifications.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer's authorized service representative.

B. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with Chicago Electrical Code.

**PART 2 - PRODUCTS**

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products and Systems, Inc.
2. American Insulated Wire Corp.
3. Encore Wire Corporation

4. General Cable Technologies Corporation
5. Southwire Company

C. Standards:

1. Listed and labeled as defined in Chicago Electrical Code, 2018, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors:

1. Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
2. Comply with NEMA WC 70/ICEA S-95-658/ASTM B-8.

E. Conductor Insulation: Comply with

1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type THHN and Type THWN-2: Comply with UL 83.
3. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
4. Type XHHW-2: Comply with UL 44, NEMA WC-70/ICEA S-95-658 and UL 83.

## 2.2 MINERAL-INSULATED CABLE, TYPE MI

A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. KME America, Inc.
2. Pentair
3. Watlow Electric Manufacturing Company

C. Standards:

1. Listed and labeled as defined in Chicago Electrical Code, 2018 Edition, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 2196-2018 for fire resistance.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper.

E. Insulation: Compressed magnesium oxide.

F. Sheath: Copper

## 2.3 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Tyco Electronics Corp.
2. 3M Electrical products Division

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with Chicago Electrical Code, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

D. Circuit Integrity Cable: Twisted shielded pair, Chicago Electrical Code, Article 760, Classification CI, for power-limited fire-alarm signal service. Type FPL. NRTL listed and labeled as complying with ASTM E119, UL 1424 and UL 2196-2018/ULC S-139 for a two-hour rating.

1. The cables shall only be permitted to be installed in a raceway where specifically listed and marked as part of an electrical circuit protective system compliant with Chicago Electrical Code art. 760.
2. The cables that are part of an electrical circuit protective system shall be identified with the protective system number and hourly rating printed on the outer jacket of the cable and installed in accordance with the listing of the protective system.

E. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196-2018 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

## 2.4 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in the Chicago Electrical Code, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC
4. 3M; Electrical Products Division
5. Tyco Electronics Corp.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper
2. Type: One or Two hole with long barrels.
3. Termination: Compression

**PART 3 - EXECUTION**

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION, APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders, indoor: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors in raceways unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

1. Emergency lighting, exit signs and other life safety circuits shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet unless indicated otherwise elsewhere on the drawings.

D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

F. Conductor Supports in Vertical Raceways:

1. Support conductors in vertical raceways in accordance with CEC 300.19 and Table 300.19(A) Spacing of Conductors Supports.
2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

## 3.4 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Section 26 05 33 "Raceways and Boxes for Electrical Systems."

1. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method: Comply with Section 28 31 11 “Digital Addressable Fire Alarm System.”

## 3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material.

C. Wiring at Outlets: Install conductor at each outlet, with at least **6 inches** of slack.

D. Comply with requirements in Section 28 31 11 “Digital, Addressable Fire-Alarm System” for connecting, terminating, and identifying wires and cables for Fire Alarm System.

## 3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 “Identification for Electrical Systems.”

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

## 3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 “Sleeves and Sleeve Seals for Electrical Raceways and Cabling.”

## 3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 “Penetration Firestopping.”

## 3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors feeding the following critical equipment and services for compliance with requirements:

    a. Fire alarm system;
    b. Emergency power and control systems.

3. Perform visual and electrical tests as required by NETA ATS:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance
    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.

h. Uniform resistance of parallel conductors.

B. MI cable shall have the insulation resistance of each cable tested with a 500-volt dc megohmeter prior to energizing the cables. Tabulate resistance values and submit to Architect/Engineer for acceptance.

C. Conductors will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

**END OF SECTION**

**SECTION 26 05 26**

**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground Distribution Grounding
2. Ground Bonding common with Lightning Protection System
3. Foundation Steel Electrodes

B. Related Requirements:

1. Section 01 78 23 “Operation and Maintenance Data”.
2. Section 26 05 43 “Underground Ducts and Raceways for Electrical Systems”.

### 1.3 REFERENCES

A. CEC – Chicago Electrical Code

B. NETA – International Electrical Testing Association Acceptance Testing Specifications

C. UL 467 Standard for Safety Grounding and Bonding Equipment.

D. NFPA 780 Standard for the Installation of Lightning Protection Systems

E. UL 96A Standard for Installation Requirements for Lightning Protection System

F. IEEE/ANSI C2 National Electrical Safety Code (NESC).

G. IEEE 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

H. IEEE C2 national Electrical Safety Code (NESC).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test Wells
2. Ground Rods
3. Ground Rings
4. Grounding Arrangements and Connections for Separately Derived Systems
5. Panelboard Grounding
6. Switchboard Grounding
7. Utility Company Equipment Grounding
8. Underground Power Distribution System Components Grounding

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 – Operation and Maintenance Data, include the following:

a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:

1) Test Wells
2) Ground Rods
3) Ground Rings
4) Grounding Arrangements and Connections for Separately Derived Systems

b. Instructions for periodic testing and inspection of grounding features at[test wells, ground rings, grounding connections for separately derived systems based on NETA ATS.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a qualified testing agency and marked for intended location and application.

B. Comply with Chicago Electrical Code.

C. Comply with UL 467 for grounding and bonding materials and equipment.

**PART 2 - PRODUCTS**

2.1 SYSTEM DESCRIPTION

A. Complete code compliant grounding and bonding system.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Electrodes:

    a. Burndy
    b. Harger
    c. NSI Industries
    d. Thomas and Betts

2. Mechanical Connectors: Bronze

    a. Burndy
    b. Harger
    c. NSI Industries
    d. Thomas and Betts

3. Exothermic Connections:

    a. Burndy
    b. Cadweld
    c. Ultraweld (Harger)

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
5. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

B. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

C. Bonding Straps: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

D. Cable assemblies shall be UL Listed.

1. Cables shall be a distinctive green (equipment ground) or green/yellow tracer (isolated ground) in color, and all jackets shall be UL, VW-1 flame rated.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Pressure Connectors: High –conductivity plated units.

E. Terminating Lugs:

1. Exothermic weld or crimp compression type.

F. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

G. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

H. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

I. Conduit Hubs: Mechanical type, terminal with threaded hub.

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Straps: Solid copper, copper lugs] Rated for 600 A.

L. U-Bolt Clamps: Mechanical type, copper, terminal listed for direct burial.

M. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated bolts.

a. Material: Die-cast zinc alloy.
b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch by 10 feet.

**PART 3 - EXECUTION**

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, size as indicated on drawings.

1. Bury at least 30 inches below grade.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

F. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

## 3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

## 3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches:

1. Install four ground rods and ground ring around the pad.
2. Ground pad-mounted equipment and noncurrent-carrying metal items associated with service equipment by connecting them to underground cable and grounding electrodes.
3. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals.
4. Bury ground ring not less than 6 inches from the foundation.
5. Comply with Utility Company standards for utility transformer grounding.

## 3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by Chicago Electrical Code:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

G. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

H. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

## 3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [tinned]bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor size as indicated on drawings for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building's foundation.

J. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
2. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
3. Make connections with clean, bare metal at points of contact.
4. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
5. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
7. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
8. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
9. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
10. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
11. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
12. Underground Connections: Hydraulic compression connection
13. Connections at Test Wells: Use compression-type connectors on conductors and make two bolted- and clamped-type connections between conductors and ground rods.

## 3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

**END OF SECTION**

**SECTION 26 05 29**

**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Steel Slotted Support Systems
2. Aluminum Slotted Support Systems
3. Conduit Support Devices
4. Support for Conductors in Vertical Conduit
5. Structural Steel for Fabricated Supports and Restraints
6. Mounting, Anchoring, and Attachment Components
7. Construction Requirements for Concrete Bases
8. Refinish and Touchup Paint

B. Related Requirements:

1. Section 03 30 00 “Cast-in-Place Concrete”
2. Section 05 50 00 “Metal Fabrications”
3. Section 07 84 13 “Penetration Firestopping”
4. Section 07 72 00 “Roof Accessories”
5. Section 09 91 13 “Exterior Painting”
6. Section 09 91 23 “Interior Painting”
7. Section 09 96 00 “High-Performance Coatings”
8. Section 26 05 33 “Raceways and Boxes for Electrical Systems”

### 1.3 REFERENCES

A. MFMA-4 Metal Framing Standards Publication.

B. AWS D1.1/D1.1M Structural Welding Code – Steel

C. AWS D1.2/D1.2M Structural Welding Code – Aluminum.

D. ASTM A36/A36M Standard Specification for Carbon Structural Steel.

E. MSS SP 58 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation

F. ASTM F3125/F3125M Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.

G. NECA "Standards of Installation"

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the support systems, hardware, and accessories.

1. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
5. Concrete bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, floor plans, elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Concrete bases.
2. Suspended ceiling components.
3. Ductwork, piping, fittings, and supports.
4. Structural members to which hangers and supports will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling, including the following:

a. Luminaires
b. Air Outlets and Inlets
c. Speakers
d. Sprinklers
e. Access Panels
f. Projectors
g. Ceiling Mounted Smoke or Heat Detectors and Fire Alarm Notification Appliances

B. Welding Certificates

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M
2. AWS D1.2/D1.2M

B. Comply with Chicago Electrical Code.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

2.3 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Subject to compliance with requirements, provide products by one of the following:

1. Allied Tube and Conduit
2. Cooper B-Line, Inc.
3. ERICO International Corp.
4. Thomas and Betts Corp.
5. Unistrut, Tyco International LTD.
6. O-Z/Gedney

B. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel.
3. Channel Width: Selected for applicable load criteria.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

1. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Material: 6063-T5 aluminum alloy.
3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
4. Channel Width: Selected for applicable load criteria.
5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

**PART 3 - EXECUTION**

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1
2. NECA 101

B. Comply with requirements in Section 07 84 13 “Penetration Firestopping” for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 26 05 33 “Raceways and Boxes” for Electrical Systems.

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by Chicago Electrical Code. Minimum rod size shall be 1/4-inch in diameter.

E. Multiple Raceways: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25-percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

## 3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners / epoxy anchors.
5. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

## 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

## 3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use **3000-psi**, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

## 3.5 PAINTING

A. Touchup: Comply with requirements in Section 09 91 13 "Exterior Painting", Section 09 91 23 “Interior Painting” and Section 09 96 00 “High-Performance Coatings” for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

C. PVC coating: Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION**

**SECTION 26 05 33**

**RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Metal Conduits and Fittings
2. Nonmetallic Conduits and Fittings
3. Metal Wireways and Auxiliary Gutters
4. Surface Raceways
5. Boxes, Enclosures, and Cabinets
6. Handholes and Boxes for Exterior Underground Cabling

B. Related Requirements:

1. Section 07 84 13 “Penetration Firestopping”
2. Section 26 05 29 “Hangers and Supports for Electrical Systems”
3. Section 26 05 43 “Underground Ducts and Raceways for Electrical Systems”
4. Section 26 05 44 “Sleeves and Sleeve Seals” for Electrical Raceways and Cabling
5. Section 27 05 28 “Pathways for Communications Systems”

### 1.3 REFERENCES

A. American National Standards Institute/national Electrical manufacturers Association (ANSI/NEMA):

1. C80.1 - Rigid Steel Conduit, Zinc-Coated
2. C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
3. C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
4. C80.6 – Intermediate Metal Conduit, Zinc Coated
5. OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
6. OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

B. National Electrical Manufacturing Association (NEMA):

1. TC-2 – Electrical Polyvinyl Chloride (PVC) Conduit.
2. TC-3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

3. RN-1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit.
4. FB-1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
5. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
6. FB.2.10 - Selection and Installation Guidelines for Fittings for Use With Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing).
7. FB 2.20 - Selection and Installation Guidelines for Fittings for Use with Flexible Electrical Conduit and Cable

C. National Electrical Contractor Association (NECA) “Standards of Installation”.

D. Underwriters Laboratories (UL) Listings:

1. UL 1 – Flexible Metal Conduit
2. UL 6 – Rigid Metal Conduit
3. UL 360 – Liquid Tight Flexible Steel Conduit
4. UL514B – Conduit Tubing and Cable Fittings
5. UL651A – Type EB and a PVC Conduit and HDPE Conduit
6. UL651B – Continuous Length HDPE Conduit
7. UL746A – Standard for Polymeric Materials – Short Term Property Evaluations
8. UL797 – Electrical Metal Tubing
9. UL1242 – Intermediate Metal Conduit
10. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit

1.4 DEFINITIONS

A. GRC: Galvanized Rigid Steel Conduit

B. EMT Electrical Metallic Tubing

C. FMC: Flexible Metal Conduit

D. IMC: Intermediate Metal Conduit

E. LFMC: Liquid-tight Flexible Metal Conduit

F. RNC: Rigid Nonmetallic Conduit

1.5 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

C. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

D. Source quality-control reports.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with Chicago Electrical Code.

**PART 2 - PRODUCTS**

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products and Systems
2. Allied Tube and Conduit
3. Anamet Electrical
4. Cooper B-Line
5. Cooper Crouse-Hinds
6. EGS/Appleton
7. O-Z/Gedney
8. Raco
9. Robroy Industries
10. Spring City Electrical Manufacturing Co.
11. Wheatland Tube Company

B. Metal Conduit:

1. GRC: Comply with ANSI C80.1 and UL 6.
2. IMC: Comply with ANSI C80.6 and UL 1242.
3. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

a. Comply with NEMA RN 1.
b. Coating Thickness: **0.040 inch**, minimum.

4. EMT: Comply with ANSI C80.3 and UL 797.
5. FMC: Comply with UL 1; zinc-coated steel.
6. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

C. Metal Fittings:

1. Comply with NEMA FB 1 and UL 514B.
2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and City of Chicago Electrical Code.
4. Fittings for EMT:

a. Material: Steel
b. Type: Compression

5. Expansion-Joint Fittings:

a. Fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits.
b. Fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
c. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
d. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

D. Joint Compound for IMC, GRC: Approved, as defined in the Chicago Electrical Code, by Authorities having Jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Tube and Conduit
2. Anamet Electrical
3. Carlon Electric Industries
4. Robroy Industries
5. Wheatland Tube Company

B. Nonmetallic Conduit:

1. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
2. LFNC: Comply with UL 1660.

C. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

a. Fittings for LFNC: Comply with UL 514B.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.
2. Hoffman
3. Square D; Schneider Electric

B. Description:

1. Enclosure: Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1
b. Outdoor Locations: NEMA 250, Type 3R
c. Kitchen Areas: NEMA 250, Type 4X, stainless steel
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5

2. Sheet metal, complying with UL 870 and NEMA 250.
3. Sized according to CCBC Chicago Electrical Code 2018 Edition.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type or Screw-cover type. Flanged-and-gasketed type when required to meet application requirements (outdoor) unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

## 2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect. All conduit in finished spaces shall be concealed. Surface mounted raceways are only permitted if approved by architect and CHA.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Thomas & Betts Corporation
b. Walker Systems, Inc.; Wiremold Company (The)
c. Wiremold Company (The); Electrical Sales Division

2.5 METAL BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Same as raceways. Subject to compliance with requirements, provide products by one of the following:

1. Advance products and Systems
2. Allied Tube and Conduit
3. Anamet Electrical
4. Carlon Electric Industries
5. Certain Teed Corp.
6. Cooper B-Line
7. Cooper Crouse-Hinds
8. EGS/Appleton
9. O-Z/Gedney
10. Raco
11. Robroy Industries
12. Spring City Electrical Manufacturing Co.
13. Wheatland Tube Company

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Metal Floor Boxes:

1. Material: Cast metal or sheet metal
2. Type: Fully adjustable
3. Shape: Rectangular

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing **50 lbs**. Outlet boxes designed for attachment of luminaires weighing more than **50 lbs**. shall be listed and marked for the maximum allowable weight.

G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing **70 lbs**.

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

K. Device Box Dimensions: **4 inches square by 2-1/8 inches deep**. Utilize extra deep boxes as required for HDMI connections.

L. Gangable boxes are allowed.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250:

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: NEMA 250, Type 1
    b. Outdoor Locations: NEMA 250, Type 3R
    c. Kitchen Areas: NEMA 250, Type 4X, stainless steel
    d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4
    e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5

2. Continuous-hinge cover with flush latch unless otherwise indicated.
3. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
4. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
5. Cabinets: Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: NEMA 250, Type 1
    b. Outdoor Locations: NEMA 250, Type 3R
    c. Kitchen Areas: NEMA 250, Type 4X, stainless steel
    d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4
    e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5

6. Galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
7. Hinged door in front cover with flush latch and concealed hinge.
8. Key latch to match panelboards.
9. Metal barriers to separate wiring of different systems and voltage.
10. Accessory feet where required for freestanding equipment.

N. Boxes installed in wet areas shall be listed and labeled as defined in the Chicago Electrical Code, by a qualified testing agency, and marked for intended location and application.

2.6 ACCESSORIES

A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes.

1. Kinetics Noise Control – IsoBacker Pad
2. SpecSeal – SSP Putty and Pads
3. 3M MPP-4S or equal

**PART 3 - EXECUTION**

## 3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC
2. Concealed Conduit, Aboveground: GRC
3. Underground Conduit: GRC, RNC, Type EPC-40-PVC, [direct buried or concrete encased as indicated elsewhere in contract documents.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT
2. Exposed, Not Subject to Severe Physical Damage: EMT
3. Exposed and Subject to Severe Physical Damage: GRC.
4. Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. As indicated elsewhere in Contract documents.

5. Concealed in Ceilings and Interior Walls and Partitions: EMT
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Damp or Wet Locations: GRC

C. Minimum Raceway Size: 3/4-inch trade size; 1/2-inch conduit can be utilized for switch legs.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install surface raceways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

## 3.2 INSTALLATION

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits.

Comply with Chicago Electrical Code limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to the Chicago Electrical Code minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed thread less fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from RNC to GRC before rising above floor.

M. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect.

W. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

X. Install raceway sealing fittings at accessible locations according to Chicago Electrical Code and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to Chicago Electrical Code.

Y. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by Chicago Electrical Code.

Z. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

AA. Expansion-Joint Fittings:

1. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

BB. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

CC. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

DD. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

EE. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

FF. Locate boxes so that cover or plate will not span different building finishes.

GG. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

HH. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

II. Set metal floor boxes level and flush with finished floor surface.

JJ. Raceways for Optical Fiber and Communications Cable: Install raceways, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
4. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.
5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12)

times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.

6. Telecommunications conduit bend radius shall be six (6) times the diameter for conduits under 2" and ten (10) times the diameter for conduits over 2".

## 3.3 CONDUIT SUPPORT

A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non- structural members, unless approved by the Architect.

C. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

D. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

F. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

## 3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

## 3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 Penetration Firestopping.

## 3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION**

**SECTION 26 05 43**

**UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Metal Conduits and Fittings, including GRC and PVC-coated steel conduit.
2. Rigid Nonmetallic Duct
3. Duct Accessories
4. Precast Concrete Handholes
5. Polymer Concrete Handholes and Boxes with polymer concrete cover.
6. Fiberglass Handholes and Boxes with polymer concrete cover.
7. Precast Manholes
8. Utility Structure Accessories

B. Related Requirements:

1. Section 01 73 00 “Execution “
2. Section 03 30 00 “Cast-in-Place Concrete”
3. Section 07 11 13 “Bituminous Dampproofing”
4. Section 07 84 13 “Penetration Firestopping”
5. Section 26 05 33 “Raceways and Boxes for Electrical Systems”
6. Section 26 05 26 “Grounding and Bonding for Electrical Systems”
7. Section 26 05 44 “Sleeves and Sleeve Seals for Electrical Raceways and Cabling”
8. Section 26 05 53 “Identification for Electrical Systems”
9. Section 31 10 00 “Site Clearing”
10. Section 31 22 14 “Earthwork”
11. Section 32 92 00 “Turf and Grasses”
12. Section 32 93 00 “Plants”

### 1.3 REFERENCES

A. ASTM C 858 Standard Specification for Underground Precast Concrete Utility Structures.

B. ASTM C 891 Standard Practice for Installation of Underground Precast Concrete Utility Structures.

C. ASTM C 1037 . Standard Practice for Inspection of Underground Precast Concrete Utility Structures.

D. AASHTO HB 17 Standard Specifications for Highway Bridges, 17th Edition

E. ANSI/SCTE 77 Specifications for Underground Enclosure Integrity

F. Comed Standard C4381

G. NIST: National Institute of Standards and Technology

H. NEMA TCB 2 Guidelines for the Selection and Installation of Underground Non-Metallic Raceways

I. Chicago Electrical Code

J. SCTE 77 Specification for Underground Enclosure Integrity

1.4 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized Rigid (steel) Conduit

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for manholes, handholes, boxes**, and other utility structures**.
4. Include underground-line warning tape.
5. Include warning planks.

B. Shop Drawings:

1. Precast Concrete Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include grounding details.
f. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
g. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

## 1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Product Certificates: For concrete and steel used in precast concrete **manholes and handholes**, as required by ASTM C 858.

C. Source quality-control reports.

D. Field quality-control reports.

## 1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with Chicago Electrical Code.

## 1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect and the CHA's Designated Representative no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect's and the CHA's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

**PART 2 - PRODUCTS**

2.1 METAL CONDUIT AND FITTINGS

A. Comply with specification section 26 05 33 "Raceways and Boxes for Electrical Systems".

2.2 RIGID NONMETALLIC DUCT

A. Comply with specification section 26 05 33 "Raceways and Boxes for Electrical Systems".

B. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems".

C. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

1. Color: Red dye added to concrete during batching.
2. Mark each plank with "ELECTRIC" in 2-inch-high, 3/8-inch-deep letters.

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Christy Concrete Products
2. Elmhurst-Chicago Stone Co.
3. Utility Concrete Products, LLC.

4. Wausau Tile Inc.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof cast-iron frame, with unhinged cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

F. Cover Legend: Molded lettering, as indicated elsewhere in contract documents, for each service.

G. Configuration: Units shall be designed for flush burial and have **closed** bottom as indicated.

H. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

1. Extension shall provide increased depth of 12 inches.
2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.

I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Center window location.
2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct.
4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
5. Knockout panels shall be 1-1/2 to 2 inches thick.

K. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

## 2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armorcast Products Company
2. MacLean Highline
3. NewBasis

4. Oldcastle Enclosure Solutions
5. Quazite: Hubbell Power Systems, Inc.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray

E. Configuration: Units shall be designed for flush burial and have **open**/**closed** bottom as indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, as indicated elsewhere in contract documents, for each service.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, waterproof fixed installation in enclosure wall.

J. Handholes **12 inches wide by 24 inches long** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.6 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armorcast Products Company
2. MacLean Highline
3. NewBasis
4. Oldcastle Enclosure Solutions
5. Quazite: Hubbell Power Systems, Inc.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray

E. Configuration: Units shall be designed for flush burial and have **open**/**closed** bottom as indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, as indicated elsewhere in contract documents for each service.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes **12 inches wide by 24 inches long** and larger shall have factory-installed inserts for cable racks and pulling-in irons.

## 2.7 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Comply with ComEd standard C4381 when installed in ComEd service entrance duct bank.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Christy Concrete Products
2. Elmhurst-Chicago Stone Co.
3. Oldcastle Precast, Inc.
4. Utility Concrete Products, LLC

D. Comply with ASTM C 858 for design and manufacturing process.

E. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

F. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Center window location.
2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct.
4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
5. Knockout panels shall be 1-1/2 to 2 inches thick.

G. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.
2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.

H. Frame and Cover: Weatherproof cast-iron frame, with unhinged cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

I. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

J. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

K. Cover Legend: Molded lettering, as indicated elsewhere in contract documents for each service.

L. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 31 10 00 “Site Clearing”. Remove and stockpile topsoil for reapplication according to Section 31 10 00 “Site Clearing”.

3.2 UNDERGROUND DUCT APPLICATION

A. Underground Ducts crossing Paved Paths, Walks and Driveways, Roadways: **GRC**, encased in reinforced concrete.

B. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 minimum structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20, Polymer concrete, SCTE 77, Tier 15, Fiberglass enclosures with polymer concrete frame and cover, SCTE 77, Tier 15, structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10, Polymer concrete units, SCTE 77, Tier 8, Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.
5. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units in sidewalk and similar applications Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 31 20 00 “Earth Moving”, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 32 92 00 “Turf and Grasses” and Section 32 93 00 “Plants”.

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 01 73 00 “Execution”.

## 3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 25 feet (long sweep), both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90-degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

G. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line duct with calculated expansion of more than 3/4 inch.

H. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 26 05 44 Sleeves and Sleeve Seals for Electrical Raceways and Cabling.

I. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

J. Pulling Cord: Install 200-lbf test nylon cord in empty ducts.

K. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 31 20 00 “Earth Moving”, for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
6. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
7. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    a. Couple RNC duct to GRC with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab

8. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
9. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

10. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
11. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00 “Cast-in-Place Concrete”. Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

L. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 31 20 00 “Earth Moving”, for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple RNC duct to GRC with adapters designed for this purpose and encase coupling with 3 inches of concrete.

b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfills to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 20 00 “Earth Moving”, for installation of backfill materials.

a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

M. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 26 05 53 “Identification for Electrical Systems”, no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

## 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 Sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
1. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
2. Install handholes with bottom below frost line, below grade.

3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
4. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Waterproofing sections of this Project Manual After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

F. Damp proofing: Apply damp-proofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Damp-proofing materials and installation are specified in Section 07 11 13 “Bituminous Dampproofing”. After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

## 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in paving and subject to occasional, nondeliberate, heavy vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screwed to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Section 03 30 00 “Cast-in-Place Concrete”, with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

## 3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

## 3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

## 3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

**END OF SECTION**

**SECTION 26 05 44**

**SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for Raceway and Cable Penetration of Non-fire-rated Construction Walls and Floors
2. Sleeve-seal Systems
3. Sleeve-seal Fittings
4. Grout
5. Silicone Sealants

B. Related Requirements:

1. Section 07 84 13 “Penetration Firestopping”
2. Section 07 92 00 “Joint Sealants”

1.3 REFERENCES

A. ASTM A53/A53M Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

B. ASTM C1107/C1107M Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

C. NECA National Electrical Contractor Association “Standards of Installation”.

D. NEMA National Electrical Manufacturers Association VE 2 Cable Tray Installation Guidelines

1.4 DEFINITIONS

A. EPDM - Ethylene Propylene Diene Monomer Rubber

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

**PART 2 - PRODUCTS**

2.1 SLEEVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

D. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The)
d. Pipeline Seal and Insulator, Inc.

e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, Dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION**

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 “Joint Sealants”.
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

## 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

## 3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

**END OF SECTION**

**SECTION 26 05 53**

**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Color and Legend Requirements for Raceways, Conductors
2. Warning Labels and Signs
3. Labels
4. Bands and Tubes
5. Tapes and Stencils
6. Tags
7. Signs
8. Cable Ties
9. Paint for Identification
10. Fasteners for Labels and Signs

B. Related requirements.

1. Section 26 05 72 “Short Circuit, Coordination and Arc Flash Study”
2. Section 26 05 19 “Low Voltage Electrical Power Conductors and Cables”

1.3 REFERENCES

A. ANSI C2 – National Electrical Safety Code

B. CEC – Chicago Electrical Code

C. ANSI A13.1 – Standard for Pipe Identification

D. ANSI Z535 series – Standards for Product Safety Signs and Labels

E. 29 CFR 1910.144 - Safety color code for marking physical hazards

F. 29 CFR 1910.145 - Specifications for accident prevention signs and tags.

G. UL-969 - Standard for Marking and Labeling Systems

H. UL-224 - Extruded Insulating Tubing

I. ASTM D 882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

1.5 QUALITY ASSURANCE

A. Comply with ASME A13.1 and IEEE C2 National Electrical Safety Code.

B. Comply with Chicago Electrical Code.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70E and Section 26 05 72 Short Circuit, Coordination and Arc Flash Study for requirements for arc-flash warning labels.

B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit] conductors.

1. Color shall be factory applied.
2. Colors for 208/120-V Circuits:

a. Phase A: Black
b. Phase B: Red
c. Phase C: Blue

3. Colors for 240-V Circuits:

a. Phase A: Black
b. Phase B: Red

4. Colors for 240/120V-V Delta Circuits:

a. High Leg - Orange

5. Colors for 480/277-V Circuits:

a. Phase A: Brown
b. Phase B: Orange
c. Phase C: Yellow

6. Color for Neutral: White or gray. Provide different neutral color for each voltage system.
7. Color for Equipment Grounds: Green.
8. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

D. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

E. Equipment Identification Labels:

1. Black letters on a white field.

## 2.3 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Equipment Identification Materials:

a. Quentin D. Schwab, 606 E. Dodson Drive, Urbana, IL 61801
b. Joe Halm Building Specialties, Box 525, LaGrange, IL
c. Mechanical Tag Systems, Box 1565, Cedar Rapids, IA 52406
d. Seton Name Plate Corp., 592 Boulevard, New Haven, CT 06505
e. N&E Specialty Co., Box 3518, Peoria, IL 61614

## 2.4 RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:

1. Power Circuits: Black letters on an orange field.
2. Legend: Indicate system or service and voltage, if applicable.

C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

## 2.5 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1- to 2-inches wide.

B. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

## 2.6 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

## 2.7 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

## 2.8 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1- to 2-inches wide; compounded for outdoor use.

C. Tape and Stencil: 4-inch wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

D. Floor Marking Tape: 2-inch wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:

1. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

3. Material:

a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.
b. Overall Thickness: 5 mils.
c. Foil Core Thickness: 0.35 mil.
d. Weight: 28 lb/1000 sq. ft.
e. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.9 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

C. Utilize 0.023 inch thick markers where exposed to damage or rough service.

D. Write-on Tags:

1. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
2. Utilize 0.023 inch thick markers where exposed to damage or rough service.
3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.10 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.

a. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.11 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.
2. Secure tight to surface of conductor, cable, or raceway.

H. Raceways and Conduit:

1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:

a. Normal Power and General Distribution: Silver
b. Emergency Power Distribution System: Orange

c. Fire Alarm: Red

I. Box Covers:

1. Box covers shall be painted to correspond with system type as follows:

a. Normal Power and General Distribution: Silver
b. Emergency Power Distribution System: Orange
c. Fire Alarm: Red

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer or load shedding.

L. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

M. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."

N. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

O. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

P. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

Q. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.

R. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

S. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

T. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

U. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

V. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

W. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

X. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6- to 8-inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench **[or concrete envelope]** exceeds 16 inches overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

Y. Metal Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using cable ties.

Z. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using cable ties.

AA. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using cable ties.

BB. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on minimum 1-1/2-inch high sign; where two lines of text are required, use signs minimum 2 inches high.

CC. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

## 3.3 IDENTIFICATION SCHEDULE

A. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

B. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch black letters on 20-inch centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30-foot maximum intervals.

C. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive vinyl tape applied in bands.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER"
2. "POWER"

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive label] with the conductor designation.

H. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Security System: Blue and yellow.
4. Mechanical and Electrical Supervisory System: Green and blue.
5. Telecommunication System: Green and yellow.
6. Control Wiring: Green and red.

I. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use metal tags. Identify each ungrounded conductor according to source and circuit number.

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

K. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

L. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

M. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with Chicago Electrical Code 2018 Edition and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

N. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

O. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

    a. Power-transfer switches.
    b. Controls with external control power connections.

P. Arc Flash Warning Labeling: Self-adhesive labels complying with requirements of the section 26 05 72.

Q. Operating Instruction Signs: Self-adhesive labels.

R. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer, load shedding.

S. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label.
2. Outdoor Equipment: Laminated acrylic or melamine sign.
3. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of an engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Switchboards.
e. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
f. Emergency system boxes and enclosures.
g. Enclosed switches.
h. Enclosed circuit breakers.
i. Enclosed controllers.
j. Variable-speed controllers.
k. Push-button stations.
l. Power-transfer equipment.
m. Contactors.
n. Remote-controlled switches, dimmer modules, and control devices.
o. Monitoring and control equipment.

**END OF SECTION**

**SECTION 26 05 72**

**OVERCURRENT PROTECTIVE DEVICE SHORT CIRCUIT, COORDINATION AND ARC FLASH STUDY**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes computer-based studies:

1. Fault-current study, to determine the minimum interrupting capacity of circuit protective devices.
2. Overcurrent protective device coordination to determine overcurrent protective devices and their settings for selective tripping.
3. Arc flash and shock hazard analysis study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.
4. All power sources rated 50 V and greater shall be included.
5. All studies shall be completed for As-Built condition reflecting all changes to the power distribution system occurred during construction. All feeder length shall be based on As Built condition.

B. Related Requirements

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 03 30 00 “Cast-in-Place Concrete”
3. Section 26 05 29 “Hangers and Supports for Electrical Systems”
4. Section 26 05 53 “Identification for Electrical Systems”
5. Section 26 28 13 “Fuses”
6. Section 01 79 00 “Demonstration and Training”

### 1.3 REFERENCES

A. Chicago Electrical Code.

B. ANSI Z535.4 Standard for Product Safety Signs and Labels

C. NFPA 70E – Standard for Electrical Safety in the Workplace.

D. IEEE-1584 2018 (Institute of Electrical & Electronic Engineers Guide for Performing Arc-Flash calculations)

E. IEEE-141 – Latest Edition (Institute of Electrical & Electronic Engineers Recommended Practice for Electric Power Systems in Commercial Buildings (IEEE Gray Book)

F. IEEE-241 – Latest Edition (Institute of Electrical & Electronic Engineers Recommended Practice for Electric Power Systems in Commercial Buildings (IEEE Gray Book)

G. IEEE-242 – Latest Edition (Institute of Electrical & Electronic Engineers Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems – Buff Book)

H. IEEE-399 – Latest Edition (Institute of Electrical & Electronic Engineers Recommended Practice for Power System Analysis – Brown Book)

I. IEEE 551 Recommended Practice for Calculating AC Short-Circuit Currents in Industrial and Commercial Power Systems

J. IEEE C57.12.00 General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

K. IEEE C57.12.10 Requirements for Liquid-Immersed Power Transformers

L. IEEE C57.96 Guide for Loading Dry-Type Distribution and Power Transformers

IEEE C37.010 Guide for AC High-Voltage Circuit Breakers > 1000 Vac Rated on a Symmetrical Current Basis

M. IEEE C37.010 Guide for AC High-Voltage Circuit Breakers > 1000 Vac Rated on a Symmetrical Current Basis

N. IEEE 1015 Recommended Practice for Applying Low Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

O. IEEE C37.20.01 Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear

P. IEEE C37.46 Specifications for High-Voltage (>1000 V) Expulsion and Current-Limiting Power Class Fuses and Fuse Disconnecting Switches

Q. IEEE 620 Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines

R. IEEE C57.12.22 Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled Three-Phase Distribution Transformers With High-Voltage Bushings, 2500 kVA and Smaller: High Voltage, 34 500 Grd Y/19 920 Volts and Below; Low Voltage, 480 Volts and Below

S. IEEE C57.12.40 Network, Three-Phase Transformers, 2500 kVA and Smaller; High Voltage, 34 500 V and Below; Low Voltage, 600 V and Below; Subway and Vault Types (Liquid Immersed)

T. NETA International Electrical Testing Association

U. NICET National Institute for Certification in Engineering Technologies

V. NEMA MG1 Motors and Generators

W. ICEA P-32-382 Short Circuit Characteristics of Insulated Cable

X. ICEA P-45-482 Short Circuit Performance of Metallic Shields and Sheaths on insulated Cable

1.4 DEFINITIONS

A. Retain terms that remain after this Section has been edited for a project.

B. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

C. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. OCPD: Overcurrent Protective Device

E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

F. SCCR: Short-circuit current rating.

G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.5 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in printed and digital form, signed, dated, and sealed by a qualified professional engineer.

1. Short-circuit study input data, including completed computer program input data sheets.
2. Short-circuit study and equipment evaluation report.
3. Include original one-line diagram as a scope document for the short-circuit study.
4. Include short circuit values at utility service locations based on the document obtained from utility company. Include copy of this document.

5. Revised single-line diagram, reflecting as-built conditions, existing system field investigation results and results of short-circuit study.
6. Coordination-study input data, including completed computer program input data sheets.
7. Study and Equipment Evaluation Reports.
8. Overcurrent protective device coordination study and equipment evaluation report.
9. Arc-flash study input data, including completed computer program input data sheets.
10. Arc-flash study report.
11. Submit study reports for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

E. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section "Operation and Maintenance Data," include the following:

a. The following parts from the Protective Device Coordination Study Report:

1) One-line diagram.
2) Protective device coordination study.
3) Time-current coordination curves.

b. Power system data.

2. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
3. Operation and Maintenance Procedures: In addition to items specified in Section "Operation and Maintenance Data," provide maintenance procedures for use by the CHA's personnel that comply with requirements in NFPA 70E.

## 1.6 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional Engineer, licensed in the state where Project is located, shall be responsible for the study and shall stamp the reports. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 399 for general study procedures.

D. Comply with Chicago Electrical Code.

**PART 2 - PRODUCTS**

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

1. SKM Systems Analysis, Inc. Power Tools for Windows v. 7.04.0 or higher.
2. Easy Power Suite, by easy Power LLC. Release 9.0 or higher.
3. ETAP by Operation Technology Inc., Version 14.0 or higher.
4. Software other than listed above can be utilized only upon approval by the Architect and the CHA.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.3 STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.

D. Short-Circuit Study:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated fault-current magnitude and angle.
c. Fault-point X/R ratio.

d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Calculated asymmetrical fault currents:

1) Based on fault-point X/R ratio.
2) Based on calculated symmetrical value multiplied by 1.6.
3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.

E. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

2. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag and title, one-line diagram with legend identifying the portion of the system covered.

b. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
c. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
d. Plot the following listed characteristic curves:

1) Device tag.
2) Voltage and current ratio for curves.
3) Maximum fault-current cutoff point.
4) Power utility's overcurrent protective device.
5) Medium-voltage equipment overcurrent relays.
6) Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
7) Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
8) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
9) Three-phase and single-phase damage points for each transformer.
10) No damage, melting, and clearing curves for fuses.
11) Cables and conductors damage curves.
12) Ground-fault protective devices.
13) Motor-starting characteristics and motor damage points.
14) Generator short-circuit decrement curve and generator damage point.
15) The largest feeder circuit breaker in each motor-control center and panelboard.

e. Provide adequate time margins between device characteristics such that selective operation is achieved.
f. Include:

1) Comments and recommendations for system improvements.
2) Completed data sheets for setting of overcurrent protective devices.

3. Tabular Format of Setting Selected for Overcurrent Protective Devices:

a. Device Tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

4. Provide adequate time margins between device characteristics such that selective operation is achieved.
5. Organize labeling on the Time Current curves so that the labels appear on the left side and go from top to bottom to match the order of devices from left to right. Single line diagram shall be located in the upper right corner whenever possible.

6. Format report so that Time Current Curves always appear on the right side of the binder and the corresponding breaker settings appear on the left side of the binder. This is to facilitate viewing of settings and curves at the same time.
7. Report shall contain hardcopy and softcopy of:

    a. Coordination study input data, including completed computer program input data sheets.
    b. Coordination curves for each major electrical equipment/circuit breaker/fuse/cable, etc.
    c. Data sheets for setting of overcurrent protective devices.

8. Overcurrent Protection Devices and Fuse Recommendations:

    a. The report preparer shall make recommendations during the design phase of the project to the A/E in regard to the specification of overcurrent protective devices and fuse ratings that provide for the lowest incident energy levels and greatest degree of coordination. The A/E shall include this information as “basis of design” on the contract documents. The AFC shall strive to avoid selection of proprietary equipment and devices and shall advise the University when such devices are necessary or warranted to achieve incident energy goals.
    b. The report preparer shall review and make recommendations during the construction phase of the project to the A/E in regard to the submitted overcurrent protective devices and fuse ratings to ensure the submitted equipment complies with the incident energy levels established during the design phase.

F. Arc Flash Study:

1. Incident Energy and Flash Protection Boundary Calculations:

    a. Arcing Fault Magnitude
    b. Protective Device Clearing Time
    c. Duration of Arc
    d. Arc-flash Boundary
    e. Working Distance
    f. Incident Energy
    g. Hazard Risk Category
    h. Recommendations for Arc-flash Energy Reduction

2. Arc Flash Warning labels:

    a. Comply with NFPA 70E requirements.
    b. Labels shall be machine printed, with no field-applied markings.
    c. Comply with requirements in Section 260553 Identification for Electrical Systems.
    d. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

        1) Location designation.
        2) Nominal voltage.
        3) Flash protection boundary.
        4) Hazard risk category.

5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

B. Proceed with coordination study only after relevant equipment submittals have been assembled.

3.2 ON SITE DATA GATHERING AND REPORTING

A. Obtain all data necessary for the conduct of the study.

1. Verify completeness of data supplied on the one-line diagram. Call any discrepancies to the attention of Architect.
2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

B. Gather and tabulate the following input data to support the short-circuit study. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Locations (room numbers) of all equipment that requires Arc Flash Hazard labels.
2. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

    a. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
    b. Proceed with coordination study only after relevant equipment submittals have been assembled.
    c. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3. Obtain electrical power utility impedance at the service.

4. Power sources and ties.
5. Short-circuit current at each system bus, three phase and line-to-ground.
6. Full-load current of all loads.
7. Voltage level at each bus.
8. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
10. For panelboards and switchboards, provide manufacturer, type and model designation, voltage and amp. Rating. List type of breaker or fuses, type of trip, SCCR, current rating, and breaker settings.
11. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
12. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Disconnects/combination motor starters: manufacturer, type, voltage and amp. Rating, SCCR, OCPD rating.
16. VFDs and equipment panels: manufacturer, type, voltage and amp. Rating, SCCR, OCPD rating.
17. Automatic transfer switches: manufacturer, type, voltage and amp. Rating, SCCR rating.
18. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
19. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 SHORT CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on the device characteristics supplied by device manufacturer.

D. The extent of the electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to the system overcurrent protective devices as follows:

1. To power distribution system low-voltage load buses.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project.

G. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

H. Calculate the maximum available short circuit current in amperes rms symmetrical at each point of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit.

I. Study electrical distribution system scenarios that result in maximum and minimum fault current. These scenarios shall include at a minimum the following:

1. Normal power system configuration.
2. Emergency power system operation.
3. Alternate sources when multiple sources and configurations are available.
4. Feeder cable length variation from modeled value +/- 10%.

J. Scenarios evaluated shall also include the maximum and minimum fault current contribution values available from Local Utilities.

K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each of the following:

1. Electric utility's supply termination point.
2. Service switchboard 0.or switchgear.
3. Low-voltage switchgear.
4. Control panels.

5. Standby generators and automatic transfer switches.
6. Distribution low voltage transformers.
7. Branch circuit panelboards.
8. Disconnect switches.

## 3.4 EQUIPMENT EVALUATION ANALYSIS

A. Confirm that interrupting ratings are equal to or higher than calculated ½ cycle symmetrical fault current for 600 Volt over current protective devices.

B. Interrupting Rating Analysis

1. Calculate momentary and interrupting duties on the basis of maximum available fault current.
2. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.

a. Transformers:

1) ANSI C57.12.10
2) ANSI C57.12.22
3) ANSI C57.12.40
4) IEEE C57.12.00
5) IEEE C57.96

b. Medium voltage Circuit Breakers: IEEE C37.010
c. Low Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.01
d. Low Voltage Fuses: IEEE C37.46.

C. Apply multiplication factors listed in the standards to ½ cycle symmetrical fault current for devices and equipment rated for asymmetrical fault current.

D. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground fault currents. Ensure that short circuit withstand ratings are equal to or higher than calculated ½ cycle symmetrical fault current.

## 3.5 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

A. Transformer Primary Overcurrent Protective Devices:

B. Device shall not operate in response to the following:

1. Inrush current when first energized.
2. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
3. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

4. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

C. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and applicable local Codes.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Protective Device Coordination. Study for all system devices (adjustable and fixed):

1. Provide TCC curves for each type of breaker down to and including the 20A and 30A breakers in branch circuit panelboards.
2. The coordination study shall include TCC curves for all devices on the emergency system and verify proper coordination thereof per NEC.
3. Perform coordination study in compliance with IEEE 399.
4. Calculate the maximum and minimum ½ cycle short circuit currents.
5. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short circuit currents.
6. Calculate the maximum and minimum ground fault currents.
7. Comply with IEEE recommendations for fault currents and time intervals.

F. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

G. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.

H. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

## 3.6 ARC-FLASH HAZARD ANALYSIS

A. Arc Flash Study Limits:

1. These study requirements exceed the requirements of the NFPA-70E standards and shall include all electrical equipment on the buildings power distribution system as described below:

a. Study from the secondary side of the service entrance transformer using fault current and X/R ratio values that the AFC obtains from the public utility.
b. All electrical panel boards.

c. All electrical equipment disconnect switches.
d. All Variable Frequency Drives (VFD).
e. All disconnect switches that are integral to equipment that is hardwired to the building electrical system.

2. The intent is that all electrical equipment subject to access while energized or that is a point of a Lock lut / Tag out operation is labeled. Notable exclusions from the study include 20 Amp lighting branch circuits, receptacle branch circuits and enclosed transformers.
3. The study requirements shall include all electrical distribution system components that are served by power source rated 50 Volts or greater.

B. Arc Flash Hazard Analysis:

1. Analysis methods shall conform to NFPA 70E and IEEE 1584.
2. Analysis shall include all voltage classes of equipment from the service entrance down to 50 Volts.
3. Analysis shall calculate and assign Arc Flash values based upon worst case operational configuration. Summaries shall indicate both conditions. Applied labels shall reflect the highest IE value. Examples include:

a. VFDs shall be assumed to be in bypass mode.

4. Calculate the Arc Flash Incident energy (IE) for each point in the system(s). This includes values for the line side of each main overcurrent device in panel boards, switchboards, MCCs.
5. Calculate the Arc Flash Boundary distances for each point in the system(s). This includes values for the line side of each main overcurrent device in panel boards, switchboards, MCCs.
6. Report shall contain hardcopy and softcopy of the Arc Flash Evaluation showing the bus name, protective device name, bus (kV), bus bolted fault (kA), protective device arcing fault (kA), trip/delay time (sec.), arc type, arc flash boundary (in.), working distance (in.), incident energy (cal/cm2), and required protective FR clothing class.
7. The completed study shall include:

a. Device Tag for each point assessed.
b. Voltage exposure at each location.
c. Available bolted fault current.
d. Hazard Risk Category.
e. Arc-Flash Protection Boundary.
f. Working Distance.
g. Incident Energy (in cal/cm2)
h. Components or equipment that have insufficient AIC for available fault current, or are over-dutied.
i. Assessment date.
j. Recommendation regarding results and how to lower hazards.
k. Data Tables: Report shall contain hardcopy and softcopy of Arc Flash Hazard Assessment data tables from SKM software.

C. Arc Flash Warning Labels

1. The contractor of the Arc Flash Hazard Analysis shall provide a 4-in. x 6-in. thermal transfer type label of high adhesion polyester for each work location analyzed.
2. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the CHA and after any system changes, upgrades or modifications have been incorporated in the system.
3. The label shall include the following information, at a minimum:

    a. Location designation
    b. Nominal voltage
    c. Flash protection boundary
    d. Hazard risk category
    e. Incident energy or energy range corresponding to reported Hazard risk category.
    f. Working distance
    g. Engineering report number, revision number and issue date.

4. Labels shall be machine printed, with no field markings.
5. Arc Flash Labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

    a. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
    b. For each motor control center, one arc flash label shall be provided.
    c. For each low voltage switchboard, one arc flash label shall be provided.
    d. For each machine control panel, one arc flash label shall be provided.
    e. For each bus duct plug, one arc flash label shall be provided.

D. Comply with NFPA 70E for hazard analysis study.

E. Use the short-circuit study output and the field-verified settings of the overcurrent devices.

F. Calculate maximum and minimum contributions of fault-current size.

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

H. Include all low-voltage equipment locations.

I. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

J. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

K. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

L. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

## 3.7 SHOCK HAZARD ANALYSIS

A. Perform a Shock Hazard Analysis in accordance with NFPA 70E. The completed study shall determine:

1. Voltage exposure at each location.
2. Shock Protection Boundaries
    a. Limited Approach.
    b. Restricted Approach
3. Required PPE for shock hazard protection.

## 3.8 ADJUSTING

A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

## 3.9 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.10 DEMONSTRATION

A. Train the CHA's maintenance personnel in the following:

1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
3. Train the CHA's operating and maintenance personnel in the use of study results.
4. Adjust, operate, and maintain overcurrent protective device settings.

B. Train the CHA's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

**END OF SECTION**

**SECTION 26 09 23**

**LIGHTING CONTROL DEVICES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:
1. Outdoor photoelectric switches, low voltage.
2. Indoor occupancy and vacancy sensors.
3. Switchbox-mounted occupancy sensors.
4. Wall-box dimmers
5. Conductors and cables.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for manual light switches.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.

3. Submit floor plans showing project-specific coverage patterns, indicating full coverage of all rooms for review and location approval.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lutron
2. Or Engineer of Record approved equal

B. Description: Solid state; one set of NO dry contacts rated for **24 V** to operate connected load, complying with UL 773, and compatible with l**ighting control panelboard**.

1. Listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Thirty-second minimum, to prevent false operation.
4. Mounting: 1/2-inch (13-mm) threaded male conduit.
5. Failure Mode: Luminaire stays ON.
6. Compatible with digital addressable lighting interface.

2.2 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lutron
2. Or Engineer of Record approved equal

B. General Requirements for Sensors:

1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Integrated power pack.
4. Hardwired connection to switch and lighting control system.
5. Listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.
6. Operation:

    a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Sensor is powered from the power pack
8. Power: Line voltage
9. Power Pack: Dry contacts rated for LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by CEC.
10. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. PIR Type: Wall or Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of **1000 square feet (110 square meters)** when mounted 48 inches (1200 mm) above finished floor.

D. Ultrasonic Type: Wall or Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet (110 square meters) above finished floor.

E. Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of **1000 square feet (110 square meters)** when mounted 48 inches (1200 mm) above finished floor.

## 2.3 DIGITAL TIMER LIGHT SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lutron
2. Or Engineer of Record approved equal

B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 5 minute increments.

1. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
2. Standards: Comply with UL 20.
3. Voltage: Match the circuit voltage

4. Coordinate color of switch and faceplate with Section 262726 "Wiring Devices."
5. Faceplate: Color matched to switch.

2.4 DIMMERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lutron
   2. Or Engineer of Record approved equal

B. Wall-Box Dimmers:
   1. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
   2. Control: Continuously adjustable slider with on/off toggle switch; with single-pole or three-way switching.
   3. Standards: Comply with UL 1472.
   4. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 10 percent of full brightness.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION OF SENSORS

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 95 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

## 3.3 INSTALLATION OF WIRING

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is ¾ inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's written instructions.

D. Size conductors in accordance with lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

## 3.4 IDENTIFICATION

A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems.

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

3.8 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.16 "Addressable-Luminaire Lighting Controls"

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

**END OF SECTION**

**SECTION 26 24 13**

**SWITCHBOARDS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service and Distribution Switchboards Rated 600 V and Less
2. Disconnecting and Overcurrent Protective Devices
3. Instrumentation
4. Control Power
5. Accessory Components and Features
6. Identification

B. Related Requirements

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 03 30 00 “Cast-in-Place Concrete”
3. Section 26 05 29 “Hangers and Supports for Electrical Systems”
4. Section 26 05 53 “Identification for Electrical Systems”
5. Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study”
6. Section 26 25 00 “Enclosed Bus Assemblies”
7. Section 26 28 13 “Fuses”

1.3 REFERENCES

A. ANSI C12.20 American National Standard for Electricity Meters – 0.2 and 0.5 Accuracy Classes.

B. ANSI C39.1 Requirements for Electrical Analog Indicating Instruments

C. ANSI C57.13 Requirements for Instrument Transformers

D. NEMA AB 1 Molded Case Circuit Breakers

E. NEMA KS 1 Enclosed Switches

F. NEMA PB 2 Dead Front Distribution Switchboards

G. NEMA PB 2.1 Instructions for Safe Handling, Installation, Operation and Maintenance of Dead front Switchboards Rated 600 Volts or less

1.4 NECA 1 Standard for Good Workmanship in Electrical Construction

1.5 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings. For each switchboard and related equipment:

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of barriers specified for electrical isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Delegated Design Submittal:

1. For short circuit, overcurrent protection devices coordination and arc-flash hazard analysis.
2. For arc-flash labels.

1.6 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 “Operation and Maintenance Data”, include the following:

a. Routine maintenance requirements for switchboards and all installed components.
b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Short circuit, overcurrent protective devices coordination and arc flash study report including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
2. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a qualified testing agency and marked for intended location and application.

C. Comply with NEMA PB 2.

D. Comply with UL 891.

E. Comply with NEMA PB 1.

F. Comply with Chicago Electrical Code, 2018 Edition.

G. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

1.11 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

C. Unusual Service Conditions: NEMA PB 2, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the CHA or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify the CHA no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without the CHA's written permission.
4. Comply with NFPA 70E.

1.12 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment,

raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.13 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

E. Nominal System Voltage: As indicated on riser diagram.

F. Main-Bus Continuous: As indicated on riser diagram.

G. Indoor Enclosures: Steel, NEMA 250, Type 1.

H. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

I. Barriers: Between adjacent switchboard sections.

J. Isolation for main bus of main section and main and vertical buses of feeder sections.

K. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

L. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

M. Customer Metering Compartment: A separate customer metering compartment with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks

N. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

O. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

P. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Removable covers shall form top, front, and sides. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
3. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

Q. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
3. Copper feeder circuit-breaker line connections.
4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Disconnect Links:

a. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems with removable disconnecting link.

7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

R. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

S. Future Provisions: In addition to the spare devices shown, provide a minimum of 15 inches of fully equipped space for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.

## 2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with **interrupting capacity** to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time adjustments.
d. Ground-fault pickup level, time delay, and I squared t response.

4. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
6. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
d. Ground-Fault Protection: **Integrally mounted** relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [**55**] [**75**] percent of rated voltage.

f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
g. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

a. Instantaneous trip.
b. Time adjustments for long- and short-time pickup.
c. Ground-fault pickup level, time delay, and I squared t response.

4. Remote trip indication and control.
5. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
6. Control Voltage: 120-V ac.

C. Arc Energy Reduction:

Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 800 amps or larger.

D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

E. Fuses are specified in Section 26 28 13 “Fuses”.

## 2.3 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
3. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus-or-minus 0.5 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus-or-minus 0.5 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus-or-minus 0.5 percent.
d. Megawatts: Plus-or-minus 1 percent.
e. Megavars: Plus-or-minus 1 percent.
f. Power Factor: Plus-or-minus 1 percent.
g. Frequency: Plus-or-minus 0.1 percent.
h. Accumulated Energy, Megawatt Hours: Plus-or-minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus-or-minus 1 percent; demand interval programmable from five to 60 minutes.
j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.

## 2.4 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.6 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

B. Comply with requirements section 26 05 53 “Identification for Electrical Systems”.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards

1. Equipment Mounting: Install switchboards on concrete base. The concrete base shall be 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 03 30 00 “Cast-in-Place Concrete”.

C. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.
5. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges based on results of the study as specified in Section 26 05 72 “Overcurrent Protective Devices Short Circuit”, Coordination and Arc Flash Study.
2. Apply Arc Flash Labels.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

## 3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 26 25 00 “Enclosed Bus Assemblies”. Drawings indicate general arrangement of bus, fittings, and specialties.

B. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per Chicago Electrical Code.

C. Support and secure conductors within the switchboard according to Chicago Electrical Code.

D. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

## 3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 05 53 Identification for Electrical Systems.

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 26 05 53 Identification for Electrical Systems.

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 26 05 53 Identification for Electrical Systems.

## 3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Acceptance Testing:

   a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
   b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per Chicago Electrical Code.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
6. Where two levels of ground fault are provided, test ground fault circuit breakers to prove selective coordination in accordance with manufacturer’s directions. Provide testing documentation with Operating & Maintenance Manual submittals.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

1. Set field-adjustable switches and circuit-breaker trip ranges based on results of the study as specified in Section 26 05 72 “Short Circuit, Overcurrent Protective Device Coordination and Arc Flush Study”.

2. Apply Arc Flash Labels as required by the study specified in Section 26 05 72 “Short Circuit, Overcurrent Protective Device Coordination and Arc Flush Study”.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Train the CHA's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

**END OF SECTION**

**SECTION 26 24 16**

**PANELBOARDS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Power distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.

B. Related Requirements

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 03 30 00 “Cast-in-Place Concrete”
3. Section 26 05 29 “Hangers and Supports for Electrical Systems”
4. Section 26 05 53 “Identification for Electrical Systems”
5. Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study”
6. Section 26 28 13 “Fuses”

1.3 REFERENCES

A. NEMA 250 Enclosures For Electrical Equipment (1000 Volts Maximum).

B. NEMA AB 1 - Molded Case Circuit Breakers

C. NEMA KS 1 - Enclosed Switches

D. NEMA PB 1 – Panelboards

E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less

F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment

1.4 UL 67 – Panelboards

1.5 DEFINITIONS

A. ATS: NETA Acceptance Testing Specification

B. GFCI: Ground-fault Circuit Interrupter

C. GFEP: Ground-fault Equipment Protection

D. MCCB: Molded-case Circuit Breaker

E. SPD: Surge Protective Device

1.6 ACTION SUBMITTALS

A. Product Data: For each type of Panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Delegated Design Submittal:

1. For short circuit, overcurrent protection devices coordination and arc-flash hazard analysis.
2. For arc-flash labels.

1.7 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data", include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

a. Short circuit, overcurrent protective devices coordination and arc flash study report including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each type.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.10 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a qualified testing agency and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with Chicago Electrical Code.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.12 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary

HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the CHA or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's written permission.
3. Comply with NFPA 70E.

1.13 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.14 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Electrical Code, 2018 edition, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with Chicago Electrical Code.

F. Enclosures: **Surface**-mounted, dead-front cabinets as indicated elsewhere in contract documents.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    b. Outdoor Locations: NEMA 250, Type 3R.
    c. Kitchen Areas: NEMA 250, Type 4Xstainless steel.
    d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Height: 84 inches maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

    a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Galvanized steel.

G. Incoming Mains:

1. Location: Top or Bottom based on field conditions.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

    a. Plating shall run entire length of bus.

b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
6. Split Bus: Vertical buses divided into individual vertical sections.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Provide oversized terminals when required for feeders upsized for voltage drop.
6. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
7. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
8. Sub feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
9. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
10. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

J. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 20 percent.

L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

## 2.2 POWER DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: As indicated on panel schedules.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

G. Branch Overcurrent Protective Devices: Fused switches.

H. Arc Energy Reduction:

1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 800 amps or larger.
2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch in the first section of the electrical equipment.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution

3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated in panel schedules.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Provide multi-pole breakers for multi-wire circuits.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.4 LOAD CENTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Load Centers: Comply with UL 67.

C. Mains: Circuit breaker as indicated in panel schedules.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.

F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

## 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. MCCB: Comply with UL 489, fully rated, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

a. Inverse time-current element for low-level overloads.
b. Instantaneous magnetic trip element for short circuits.
c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

a. RMS sensing.
b. Field-replaceable rating plug or electronic trip.
c. Digital display of settings, trip targets, and indicated metering displays.
d. Multi-button keypad to access programmable functions and monitored data.
e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
f. Integral test jack for connection to portable test set or laptop computer.
g. Field-Adjustable Settings:
    1) Instantaneous trip.
    2) Long- and short-time pickup levels.
    3) Long and short time adjustments.
    4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.

5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Sub feed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. UL listed for reverse connection without restrictive line or load ratings.
    d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
    f. Ground-Fault Protection: **Integrally mounted** relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
    i. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
    j. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    k. Multipole units enclosed in a single housing with a single handle.
    l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position as indicated elsewhere in contract documents.
    m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 26 28 13 "Fuses."
2. Fused Switch Features and Accessories:

    a. Standard ampere ratings and number of poles.
    b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
    c. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.

1. Circuit directory shall identify specific purpose with detail enough to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail enough to distinguish it from all other circuits.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in Chicago Electrical Code.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Equipment Mounting: Install distribution panelboards on concrete base when indicated on floor plans or is required by the manufacturer installation instructions. The concrete base shall be 4-inch nominal thickness. Comply with requirements for concrete base specified in and Section 03 30 00 “Cast-in-Place Concrete.”
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount 6ft to the handle of the highest device above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

J. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

L. Install filler plates in unused spaces.

M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

O. Mount spare fuse cabinet in accessible location.

## 3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate CHA's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

## 3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 72 “Short Circuit, Overcurrent Protective Device Coordination and Arc Flash Study”. Affix Arc Flash Labels.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

## 3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

**END OF SECTION**

**SECTION 26 27 13**

**ELECTRICITY METERING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes electricity metering, work to accommodate utility company revenue meters.

B. Related Requirements

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 03 30 00 “Cast-in-Place Concrete”
3. Section 26 05 29 “Hangers and Supports for Electrical Systems”
4. Section 26 05 53 “Identification for Electrical Systems”
5. Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study”
6. Section 26 28 16 “Enclosed Switches and Circuit Breakers”
7. Section 26 43 13 “Surge Protection for Low-Voltage Electrical Power Circuits”
8. Section 26 28 13 “Fuses”
9. Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”
10. Section 27 15 13 “Communications Copper Horizontal Cabling”

### 1.3 REFERENCES

A. Chicago Electrical Code

B. NEMA 250 Enclosures For Electrical Equipment (1000 Volts Maximum).

C. NECA 1 Standard for Good Workmanship in Electrical Construction

D. NECA 400 Standard for Installing and Maintaining Switchboards

E. UL 67 Standard for Safety Panelboards

F. UL 98 Standard for Safety Enclosed and Dead-Front Switches

G. UL 916 Standard for Safety Energy Management Equipment

H. UL 1449 Standard for Safety Surge Protective Devices

I. NFPA 70E Standard for Electrical safety in the Workplace

J. Comed Metering Standards

1.4 ACTION SUBMITTALS

A. Product Data:

1. For metering infrastructure components.

B. Shop Drawings: For electricity-metering equipment.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: As specified in Section 01 78 23 "Operation and Maintenance Data."

1.6 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by the CHA or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. The CHA shall be notified and issued written permission no fewer than seven working days in advance of proposed interruption of electrical service.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Electrical Code, by a qualified testing agency, and marked for intended location and application.

B. Comply with Chicago Electrical Code.

C. Comply with UL 916.

1.8 WARRANTY

A. Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.

1.9 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.

a. Comply with requirements of utility providing electrical power services.
b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

**PART 2 - PRODUCTS**

2.1 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by the utility company, complying with its requirements.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets:

1. Comply with requirements of electrical-power utility company.
2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

D. Arc-Flash Warning Labels:

1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study”. Apply for each work location included in the analysis.

E. Current-Transformer Cabinet: Size and configuration as required by Utility company.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to switchboard installation requirements in NECA 400.

D. Install arc-flash labels as required by Chicago Electrical Code.

E. Wiring Method:

1. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 27 15 13 “Communications Copper Horizontal Cabling”.
3. Minimum conduit size shall be **1/2 inch**.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems”.

1. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections. Comply with NETA ATS specifications.

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:
2. Electrical Tests:

a. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers as specified in specification section 26 28 16 “Enclosed Switches and Circuit Breakers.”

1. Visual and Mechanical Inspection.
2. Electrical Tests.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each meter center tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.4 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

1. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study.”

**END OF SECTION**

**SECTION 26 27 26**

**WIRING DEVICES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard-grade Receptacles, 125 V, 20 A
2. GFCI Receptacles, 125 V, 20 A
3. Tamper Resistant Duplex Receptacles, 125V, 20A
4. Weather Resistant Duplex Receptacles, 120V, 20A
5. Twist-locking Receptacles
6. Cord and Plug Sets
7. Toggle Switches, 120 V, 20 A
8. Residential Devices
9. Floor Service Fittings
10. Multioutlet Assemblies
11. Wall Plates

B. Related Requirements

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 26 05 29 “Hangers and Supports for Electrical Systems”
3. Section 26 05 53 “Identification for Electrical Systems”
4. Section 26 28 13 “Fuses”
5. Section 27 15 13 “Communications Copper Horizontal Cabling”

C. Chicago Electrical Code.

D. RoHS Restriction of Hazardous Substances. RoHS,Directive

E. NEMA WD 1 General Color Requirements for Wiring Devices

F. NEMA WD 6 Wiring Devices - Dimensional Specifications

G. NEMA FB 11 Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations

H. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

I. NECA 1 Standard for Good Workmanship in Electrical Construction

J. FS W-S-896 Switches, Toggle (Toggle and Lock), Flush Mounted (general Specification)

K. FS W-C-596 Connector, Electrical Power, general Specification for

L. UL 20 UL Standard for Safety General-Use Snap Switches

M. UL 498 Attachment Plugs and receptacles

N. UL 514C UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

O. UL 943 UL Standard for Safety Ground-Fault Circuit-Interrupters

P. UL 1203 UL Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations

Q. UL 1310 UL Standard for Safety Class 2 Power Units

R. UL 1436 UL Standard for Safety Outlet Circuit Testers and Similar Indicating Devices

S. UL 1449 UL Standard for Safety Surge Protective Devices

T. UL 1699 UL Standard for Safety Arc-Fault Circuit-Interrupters

U. UL 2459 UL Standard for Safety Insulated Multi-Pole Splicing Wire Connectors

V. IEEE C62.41.2 recommended Practice on Characterization of Surges in Low Voltage (1000V and less) AC Power Circuits.

W. IEEE C62.45 Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

X. NFPA 99 Healthcare Facilities Code

1.3 DEFINITIONS

A. AFCI: Arc-fault Circuit Interrupter

B. BAS: Building Automation System

C. GFCI: Ground-fault Circuit Interrupter

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. SPD: Surge Protective Device

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

C. Comply with Chicago Building Code.

D. RoHS compliant.

E. Comply with NEMA WD 1.

**PART 2 - PRODUCTS**

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

B. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

## 2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper)
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
3. Leviton Mfg. Company Inc. (Leviton)
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour)

B. Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.

C. Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.
4. Marking: Listed and labeled as complying with Chicago Electrical Code "Tamper-Resistant Receptacles" Article 406.12.

## 2.3 GFCI RECEPTACLES, 125 V, 20 A

A. Subject to compliance with requirements, provide products by one of the following:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper)
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
3. Leviton Mfg. Company Inc. (Leviton)
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour)

B. Duplex GFCI Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Feed or Non-feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

C. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Feed or Non-feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
5. Marking: Listed and labeled as complying with Chicago Electrical Code, "Tamper-Resistant Receptacles" Article 406.12.

D. Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5- 20R.
3. Wet location listing “While in use”.
4. Type: Non-feed through.
5. Standards: Comply with UL 498 and UL 943 Class A.
6. Marking: Listed and labeled as complying with Chicago Electrical Code, "Receptacles in Damp or Wet Locations" articles.

## 2.4 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Receptacles, voltage configuration and ampere rating as indicated elsewhere in contract documents,

B. PENDANT CORD-CONNECTOR DEVICES Description: Matching, locking type plug and receptacle body connector, heavy-duty grade.

C. Configuration: as required for equipment connected or indicated elsewhere in contract documents.

D. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

E. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

F. Standards: Comply with FS W-C-596.

## 2.5 CORD AND PLUG SETS

A. Devices for CHA-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

B. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

C. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

D. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.6 TOGGLE SWITCHES, 120V, 20 A

A. Subject to compliance with requirements, provide products by one of the following:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper)
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
3. Leviton Mfg. Company Inc. (Leviton)
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour)

B. Single-Pole Switches, 120V, 20 A.

1. Standards: Comply with UL 20 and FS W-S-896.

C. Antimicrobial, Single-Pole Switches, 120V, 20 A.

1. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
2. Standards: Comply with UL 20 and FS W-S-896.

D. Two-Pole Switches, 120V, 20 A.

1. Comply with UL 20 and FS W-S-896.

E. Three-Way Switches, 120V, 20 A.

1. Comply with UL 20 and FS W-S-896.

F. Four-Way Switches, 120V, 20 A.

1. Standards: Comply with UL 20 and FS W-S-896.

G. Pilot-Light, Single-Pole Switches: 120V, 20 A.

**1.** Description: Illuminated when switch is **on/off.**
2. Standards: Comply with UL 20 and FS W-S-896.

H. Lighted Single-Pole Switches, 120V, 20 A.

**1.** Description: Handle illuminated when switch is **on/off.**
2. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

I. Key-Operated, Single-Pole Switches, 120V, 20 A.

1. Description: Factory-supplied key in lieu of switch handle.
2. Standards: Comply with UL 20 and FS W-S-896.

J. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120V, 20 A.

1. Description: For use with mechanically held lighting contactors.
2. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

K. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120V, 20 A.

1. Description: For use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
2. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

## 2.7 RESIDENTIAL DEVICES

A. Subject to compliance with requirements, provide products by one of the following:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper)
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
3. Leviton Mfg. Company Inc. (Leviton)
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour)

B. Residential-Grade, Tamper-Resistant, GFCI Receptacles, 125 V, 20 A.

1. Configuration: NEMA WD 6, Configuration 5-20R.
2. Feed-through connectors.
3. Standards: Comply with UL 943 and UL 1699.

C. Residential-Grade, Tamper-Resistant, AFCI Receptacles, 125 V, 20 A.

1. Configuration: NEMA WD 6, Configuration 5-20R.
2. Feed-through connectors.
3. Standards: Comply with UL 943 and UL 1699.

D. Residential-Grade, Tamper-Resistant Receptacles, 125 V, 20 A.

1. Configuration: NEMA WD 6, Configuration 5-20R.
2. Feed-through connectors.
3. Standards: Comply with UL 498.

E. Weather- and Tamper-Resistant Receptacles, 125 V, 20 A.

1. Configuration: NEMA WD 6, Configuration 5-15R.
2. Feed-through connectors.
3. Standards: Comply with UL 498.
4. Marked as "Weather Resistant While in use."

F. Fan-Speed Controls.

1. Description: Modular, 120-V ac, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
2. Standards: Comply with UL 1917.
3. Continuously adjustable slider, 5 A.

## 2.8 FLOOR SERVICE FITTINGS

A. Subject to compliance with requirements, provide products by one of the following:

1. Wiremold
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour)

B. Flush-Type Floor Service Fittings:

1. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
2. Compartments: Barrier separates power from voice and data communication cabling.
3. Service Plate and Cover: Rectangular, die-cast aluminum. with satin finish.
4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
5. Data Communication Outlet: Refer to Division 27 specifications.

## 2.9 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Description: Two-piece surface metal raceway, field wired.

B. Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
2. Wiremold
3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour)

C. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

D. Raceway Material: Metal, with manufacturer's standard finish.

E. Multioutlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: as indicated on floor plans.
3. Circuiting: as indicated on floor plans.

2.10 DEVICE COLOR

A. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by Chicago Building Code, 2018 Edition or device listing.

B. Wiring Devices Connected to Emergency Electrical System: Red.

C. Isolated-Ground Receptacles: Orange

2.11 WALL PLATES COLOR AND FINISH

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Painted metal
3. Material for Residential Spaces: Painted Metal
4. Material for Unfinished Spaces: Galvanized steel.
5. Material for Damp and Wet Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in wet and damp locations.
6. For painted metal covers match device color as selected by Architect.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover, WP while-in-use.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls in the middle of the block or brick so that the cover plate does not cross a joint.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with Chicago Electrical Code, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pig tailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles top, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi gang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

## 3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Emergency Electrical System: Mark receptacles supplied from the emergency electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions remove malfunctioning units and replace with new ones, and retest as specified above.

**END OF SECTION**

**SECTION 26 28 13**

**FUSES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control Circuits
b. Panelboards
c. Enclosed Controllers
d. Enclosed Switches

2. S-Type Fuses
3. Spare-fuse Cabinets

B. Related Requirements:

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 26 05 53 “Identification for Electrical Systems”

1.3 REFERENCES

A. Chicago Electrical Code

B. NEMA FU 1 Low Voltage Cartridge Fuses

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
5. Coordination charts and tables and related data.

## 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data" include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
4. Coordination charts and tables and related data.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

## 1.7 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than **40 deg F** or more than **100 deg F**, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

## 1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with Chicago Electrical Code.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bussmann
2. Littelfuse, Inc.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

### 2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: [250] [600]-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Type RK-5: [250] [600]-V, zero- to 600-A rating, 200 kAIC, time delay.
3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC time delay.
4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC time delay.
5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
7. Type T: 600-V, zero- to 800-A rating, 200 kAIC, very fast acting.

### 2.3 S-TYPE FUSES

A. Characteristics: Dual element time delay plug fuse to use with Chicago Code compliant life safety panelboards, 15 or 20A as indicated in panel schedules.

### 2.4 FUSEHOLDERS

A. Provide fuse holders to accommodate the fuses specified. Coordinate installation with assembly manufacturers as applicable. Provide pins or other physical rejection features when current limiting fuses are specified, and non-current limiting fuses of the same dimensions are available.

### 2.5 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in **1-1/2-inch**-high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
1. Service Entrance: Class T, fast acting.
2. Feeders: Class L, time delay Class RK1, time delay Class RK5, time delay Class J, Class J, time delay.
3. Motor Branch Circuits: [Class RK1] [Class RK5] [Class CC, motor duty], time delay.
4. Large Motor Branch (601-4000 A): Class L, time delay.
5. Power Electronics Circuits: [Class J, high speed] [Class T, fast acting].
6. Other Branch Circuits: [Class RK1, time delay] [Class RK5, time delay] [Class J, fast acting] [Class J, time delay] [Class CC, fast acting].
7. Control Transformer Circuits: Class CC, time delay, control transformer duty.
8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.
9. Life safety panelboards (renovation projects, existing systems): S-type fuses.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems," and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

**END OF SECTION**

**SECTION 26 28 16**

**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible Switches
2. Nonfusible Switches
3. Enclosures

B. Related Requirements

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 03 30 00 “Cast-in-Place Concrete”
3. Section 26 05 29 “Hangers and Supports for Electrical Systems”
4. Section 26 05 53 “Identification for Electrical Systems”
5. Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study”
6. Section 26 28 13 “Fuses”

1.3 REFERENCES

A. NEMA 250 Enclosures For Electrical Equipment (1000 Volts Maximum).

B. NEMA KS1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)

A. NEMA FU1 NEMA FU 1 Low Voltage Cartridge Fuses

B. NEMA AB1 Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

C. NFPA 70E Standard for Electrical safety in the Workplace

D. NECA 1 Standard for Good Workmanship in Electrical Construction

E. Chicago Electrical Code

F. UL 50 UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations

G. UL 98 UL Standard for Safety Enclosed and Dead-Front Switches

H. UL 489 UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.4 DEFINITIONS

A. ATS: NETA Acceptance Testing Specification

B. NC: Normally Closed

C. NO: Normally Open

D. SPDT: Single Pole, Double Throw

E. MCCB: Molded Case Circuit Breaker

F. GFCI: Ground-fault Circuit Interrupter

G. GFEP: Ground-fault Equipment Protection

1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 “Operation and Maintenance Data,” include the following:

    a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
    b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

## 1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, by an NRTL, and marked for intended location and application.

B. Comply with Chicago Electrical Code.

## 1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

## 1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

2.2 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a Brand of Schneider Electric

B. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600-V ac.
4. 1200 A and smaller, ampere rating as indicated elsewhere in contract documents
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses as indicated elsewhere in contract documents.
6. Lockable handle with capability to accept three padlocks and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

## 2.3 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric

B. Type HD, Heavy Duty:

1. Single Throw
2. Three Pole
3. 600-V ac.
4. 1200 A and smaller, ampere rating as indicated elsewhere in contract documents
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses as indicated elsewhere in contract documents.
6. Lockable handle with capability to accept three padlocks and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: **[One] [Two]** NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.
8. .

## 2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen Areas: NEMA 250, Type 4X, stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
6. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

C. Enclosure Finish: Manufacturer standard finish for respective NEMA 250 Type enclosure.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with Chicago Electrical Code and NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 Identification for Electrical Systems.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections. Comply with NETA ATS specifications.

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance.
h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections.
b. Measure contact resistance across each switchblade fuseholder.
c. Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Measure fuse resistance.
d. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance .
g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole.
c. Perform a contact/pole resistance test.
d. Perform insulation resistance tests on all control wiring with respect to ground.
e. Determine the following by primary current injection:

1) Long-time pickup and delay.
2) Short-time pickup and delay.
3) Ground-fault pickup and time delay.
4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
g. Verify correct operation of auxiliary features such as trip and pickup indicators; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
h. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

## 3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

1. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study.”

**END OF SECTION**

**SECTION 26 29 13**

**MANUAL AND MAGNETIC MOTOR CONTROLLERS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Combination enclosed full-voltage magnetic motor controllers.
3. Enclosed reduced-voltage magnetic motor controllers.
4. Enclosures.
5. Accessories.
6. Identification.

B. Related Requirements

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 03 30 00 “Cast-in-Place Concrete”
3. Section 26 05 29 “Hangers and Supports for Electrical Systems”
4. Section 26 05 53 “Identification for Electrical Systems”
5. Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study”
6. Section 26 28 13 “Fuses”

1.3 REFERENCES

A. UL 508 industrial Control equipment

B. UL 508A Standard for Industrial Control Panels

C. UL 508E Outline of Investigation for IEC Type "2" Coordination Short Circuit Tests of Electromechanical Motor Controllers in Accordance with IEC Publication 947-4-1

D. UL 489 UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

E. UL 60947-4-1 Safety Low-Voltage Switchgear and Control gear – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters.

F. UL 1053 Standard for Safety Ground-Fault Sensing and Relaying Equipment

G. UL 1203 Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations

H. NFPA 70E Handbook for Electrical Safety in the Workplace

I. NFPA 70B Recommended Practice for Electrical Equipment Maintenance

J. NETA ATS International Electrical Testing Association, Acceptance testing Specifications.

K. NEMA ICS 2-2000 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts

L. NEMA KS 1 Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)

M. NEMA AB 3 Molded Case Circuit Breakers and Their Application.

N. NEMA ICS 5 Industrial Control and Systems: Control-Circuit and Pilot Devices

O. NEMA ICS 6 Industrial Control and Systems: Enclosures.

P. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

1.4 DEFINITIONS

A. CPT: Control Power Transformer

B. MCCB: Molded-case Circuit Breaker

C. MCP: Motor Circuit Protector

D. NC: Normally Closed

E. OCPD: Overcurrent Protective Device

F. SCCR: Short-circuit Current Rating

G. SCPD: Short-circuit Protective Device

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of magnetic controller:

1. Include plans, elevations, sections, and mounting details.

2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

    a. Listing document proving Type 2 coordination.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 01 78 23 “Operation and Maintenance Data,” include the following:

    a. Routine maintenance requirements for magnetic controllers and installed components.
    b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
    c. Manufacturer's written instructions for setting field-adjustable overload relays.
    d. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.9 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Electrical Code, by a qualified testing agency, and marked for intended location and use.

B. Comply with Chicago Electrical Code.

C. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.

D. NEMA Compliance: Fabricate motor controllers to comply with NEMA ICS 2-2000.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.11 FIELD CONDITIONS

A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the CHA or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify the CHA no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without the CHA's written permission.
4. Comply with NFPA 70E.

**PART 2 - PRODUCTS**

2.1 MANUAL MOTOR CONTROLLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a Brand of Schneider Electric

B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Configuration: Nonreversing.
2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
3. Pilot Light: Red.

C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Configuration: Non-reversing.
2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button bimetallic type.

2.2 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.

B. Standard: Comply with NEMA ICS 2, general purpose, Class A.

C. Configuration: Nonreversing.

D. Contactor Coils: Pressure-encapsulated type.

1. Operating Voltage: Manufacturer's standard, unless indicated.

E. Control Power:

1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

F. Overload Relays:

1. Thermal Overload Relays:

a. Inverse-time-current characteristic.
b. Class 20 tripping characteristic.
c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Switch or dial selectable for motor-running overload protection.
e. Sensors in each phase.
f. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

## 2.3 COMBINATION ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution
3. Siemens Energy & Automation, Inc.
4. Square D; a Brand of Schneider Electric

C. Configuration: Nonreversing.

D. Contactor Coils: Pressure-encapsulated type.

1. Operating Voltage: Manufacturer's standard, unless indicated.

E. Control Power:

1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

F. Overload Relays:

1. Solid-State Overload Relay:

a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.

c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

G. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

H. Non-fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, non-fusible switch.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

## 2.4 ENCLOSURES

A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.

B. The construction of the enclosures shall comply with NEMA ICS 6.

C. Controllers in hazardous (classified) locations shall comply with UL 1203.

## 2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.

a. Push Buttons: As indicated in the controller schedule.
b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours; non-resettable.
3. Phase-failure.
4. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
5. Under/overvoltage: operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

## 2.6 IDENTIFICATION

A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 26 05 53 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

B. Arc-Flash Warning Labels:

1. Comply with requirements in Section 26 05 72 “Overcurrent Protective Devices Short Circuit, Coordination and Arc Flash Study”. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
2. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

    a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

        1) Location designation.
        2) Nominal voltage.
        3) Flash protection boundary.
        4) Hazard risk category.
        5) Incident energy.
        6) Working distance.
        7) Engineering report number, revision number, and issue date.

    b. Labels shall be machine printed, with no field-applied markings.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 29 “Hangers and Supports for Electrical Systems" unless otherwise indicated.

C. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 26 05 29 “Hangers and Supports for Electrical Systems” and Section 033000 “Cast-in-Place Concrete.”

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and Chicago Electrical Code.

E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

F. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by the Chicago Electrical Code for motors that are high-torque, high-efficiency, and so on.

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 “Identification for Electrical Systems”.

## 3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
2. Comply with NETA ATS requirements.
3. Visual and Mechanical Inspection:
    a. Compare equipment nameplate data with drawings and specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Inspect contactors:
        1) Verify mechanical operation.
        2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
    f. Motor-Running Protection:
        1) Verify overload element rating is correct for its application.
        2) If motor-running protection is provided by fuses, verify correct fuse rating.
    g. Inspect bolted electrical connections for high resistance.
    h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
4. Electrical Tests:
    a. Perform insulation-resistance tests on each pole, phase-to-phase and phase-to-ground
    b. Measure fuse resistance.
    c. Test motor protection devices according to manufacturer's published data.
    d. Operate the circuit breaker to ensure smooth operation.
    e. For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
    f. Perform operational tests by initiating control devices.

C. Act on inspection results and recommended action, as recommended by NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as the CHA's operations permit. Retest until deficiencies are corrected.

D. Motor controller will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controller will be considered defective if it does not pass the system function tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Train the CHA's maintenance personnel to adjust, operate, and maintain controllers.

**END OF SECTION**

**SECTION 26 36 00**

**TRANSFER SWITCHES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes automatic transfer switches rated 600 V and less, including the following:

1. Open transition automatic transfer switches.

B. Related requirements

1. Section 01 78 23 “Operation and Maintenance Data”
2. Section 01 40 00 “Quality Requirements”
3. Section 01 73 00 “Execution”
4. Section 03 30 00 “Cast-in-Place Concrete”
5. Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”
6. Section 26 05 26 “Grounding and Bonding for Electrical Systems”
7. Section 26 05 29 “Hangers and Supports for Electrical Systems”
8. Section 26 05 33 “Raceways and Boxes for Electrical Systems”
9. Section 26 05 53 “Identification for Electrical Systems”
10. Section 27 15 13 “Communications Copper Horizontal Cabling”

1.3 REFERENCES

A. ISO 900 International Standardization Organization Standard Quality System - Model for Quality Assurance in Design / Development, Production, Installation and Servicing.

B. ISO 9002 International Standardization Organization Standards Quality System - Model for Quality Assurance in Production, Installation and Servicing.

C. Chicago Electrical Code.

D. NEMA ICS 1 Industrial Control and Systems – General Requirements

E. NFPA 110 Standard for Emergency and Standby Power Systems

F. UL 1008 Transfer Switch Equipment

G. IEEE C62.62 IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage AC Power Circuits

H. NETA ATS international Electrical testing Association, Acceptance Testing Specifications

I. NEMA 250 Enclosures for Electrical Equipment

J. NEMA ICS 6 Enclosures

K. UL 508 Standard for Industrial Control Equipment

L. NECA 1 Standard for Good Workmanship in Electrical Construction

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, power sources, and load.
4. Riser Diagram: Show interconnection wiring between transfer switches, annunciators, and control panels.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 “Operation and Maintenance Data,” include the following:

a. Features and operating sequences, both automatic and manual.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a qualified testing agency and marked for intended location and application.

C. Comply with Chicago Electrical Code.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 110.

F. Comply with UL 1008.

1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by the CHA or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify the CHA no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the CHA's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 12 months from date of Substantial Completion.

## PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Short-time withstand capability for 30 cycles.

C. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Power sources for emergency or standby shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources.

F. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

G. Neutral Terminal: Solid and fully rated unless otherwise indicated.

H. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable **with printed** markers at terminations. Color-coding and wire and cable markers are specified in Section 26 05 53 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via **front** access.

J. Enclosures: General-purpose NEMA 250, **Type 1** complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

## 2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Generac Electric Company

B. Comply with Level 1 equipment according to NFPA 110.

C. Rating and configuration: Refer to riser diagram.

D. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
   4. Conductor Connectors: Suitable for use with conductor material and sizes.
   5. Material: Hard-drawn copper, 98 percent conductivity.
   6. Main and Neutral Lugs: Mechanical type unless otherwise indicated on the drawings.
   7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   8. Provide oversized termination lugs to accommodate conductors upsized for voltage drop.
   9. Ground bar.
   10. Connectors shall be marked for conductor size and type according to UL 1008.

E. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

   1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

G. Digital Communication Interface: Matched to capability of remote annunciator.

H. Automatic Transfer-Switch Controller Features:

   1. Controller operates through a period of loss of control power.
   2. Undervoltage Sensing for Each Phase of Normal and Alternate Source:

      a. Sense low phase-to-ground voltage on each phase for Utility to Utility transfer.
      b. Sense low phase-to-ground voltage on each phase for normal side and single-phase sensing on emergency side for Utility to Generator transfer.
      c. Pickup voltage shall be adjustable from 85 to 100 percent of nominal.
      d. Dropout voltage shall be adjustable from 75 to 98 percent of pickup value.
      e. Factory set for pickup at 90 percent and dropout at 85 percent.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset adjustable intervals. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.
    d. Exerciser monitoring and recording date, time start and time stop for each exercise cycle for the emergency generator.

13. Unless specified elsewhere, the ATS shall have an integral in-phase monitor that shall be inherently built into the controls. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents and shall not require external control of power sources.

I. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

J. Pilot Lights: Indicate source to which load is connected.

K. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Alternative Source Available."

L. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

M. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Mechanical type.
6. Ground Lugs and Bus-Configured Terminators: Mechanical type.
7. Ground bar.
8. Connectors shall be marked for conductor size and type according to UL 1008.

## 2.3 TRANSFER SWITCH ACCESSORIES

A. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:

a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Switch position.
c. Switch in test mode.
d. Failure of communication link.

4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

a. Indicating Lights: Grouped for each transfer switch monitored.
b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
d. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008 and NETA ATS, performed on representative devices, for emergency and legally required systems.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 “Cast-in-Place Concrete”.
2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
3. Provide workspace and clearances required by the Chicago Electrical Code.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

C. Identify components according to Section 26 05 53 “Identification for Electrical Systems.”

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to the CHA if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems".

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

E. Connect wiring according to Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”.

F. Connect twisted pair cable according to Section 27 15 13 “Communications Copper Horizontal Cabling”.

G. Route and brace conductors according to manufacturer's written instructions and Section 26 05 29 “Hangers and Supports for Electrical Systems.” Do not obscure manufacturer's markings and labels.

H. Final connections to equipment shall be made with liquid tight, flexible metallic conduit no more than 18 inches in length.

## 3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Conduct visual and mechanical inspection
3. Conduct electrical Tests as required by manufacturer and NETA ATS:
4. Check for electrical continuity of circuits and for short circuits.
5. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
6. Verify that manual transfer warnings are properly placed.
7. Perform manual transfer procedure. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
8. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Transfer switches will be considered defective if they do not pass tests and inspections.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. Train the CHA's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

**END OF SECTION**

**SECTION 26 43 13**

**SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 26 24 13 “Switchboards”
2. Section 26 24 16 “Panelboards”
3. Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”

### 1.3 REFERENCES

A. Chicago Electrical Code.

B. IEEE C62.41.2 IEEE Guide for Surge Voltages AC Power Circuits.

C. IEEE C62.45, IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.

D. UL 1449 4$^{th}$ edition Standard for Safety for Surge Protective Devices.

E. UL 1283 Electromagnetic Interference Filters.

F. NEMA 250 Enclosures for Electrical Equipment.

G. NECA 1 Standard for Good Workmanship in Electrical Construction

### 1.4 DEFINITIONS

A. I Nominal: Nominal Discharge Current

B. MCOV: Maximum Continuous Operating Voltage

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide Varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent Protective Device

F. SCCR: Short-circuit Current Rating

G. SPD: Surge Protective Device

H. VPR: Voltage Protection Rating

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, I nominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

## 1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

## 1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

## 1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Ten years from date of Substantial Completion.

## 1.9 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Comply with Chicago Electrical Code.

C. Comply with UL 1449, 4th Edition.

D. Comply with IEEE C62.41.2.

E. Comply with IEEE C62.45.

F. Comply with UL 1283.

G. MCOV of the SPD shall be the nominal system voltage.

1.10 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed electrical service interruptions.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Service Conditions: Rate SPD for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

**PART 2 - PRODUCTS**

2.1 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology Inc.; Thomas and Betts Power Solutions.
2. Liebert Corporation; a division of Emerson Network Power.
3. Advanced Protection Technologies, Inc.

B. SPDs: Comply with UL 1449, 4th edition, Type 1.

1. SPDs with the following features and accessories:

a. Integral disconnect switch when required by contract documents, see drawings for details.

b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
c. Short-circuit current rating complying with UL 1449 4th Edition, and matching or exceeding short-circuit current value available at the point of connection.
d. Fabrication using bolted compression lugs for internal wiring.
e. Redundant suppression circuits.
f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
g. Indicator light display for protection status.
h. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
i. Surge counter.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 208Y/120 V.
3. Line to Line: 1000 V for 208Y/120 V.

E. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V
3. Line to Line: 1000 V.

F. SCCR: Equal or exceed 100 kA.

G. I nominal Rating: 20 kA.

## 2.2 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology Inc.; Thomas and Betts Power Solutions.
2. Liebert Corporation; a division of Emerson Network Power.
3. Advanced Protection Technologies, Inc.

B. SPDs: Comply with UL 1449 4th edition, Type 2.

a. Integral disconnect switch when required by contract documents, see drawings for details.
b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

c. Short-circuit current rating complying with UL 1449 4th Edition and matching or exceeding short-circuit current value available at the point of connection.
d. Fabrication using bolted compression lugs for internal wiring.
e. Redundant suppression circuits.
f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
g. Indicator light display for protection status.
h. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
i. Surge counter.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Neutral to Ground: 700 V for 208Y/120 V.
3. Line to Line: 1200 V for 208Y/120 V.

E. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V
2. Line to Ground: 700 V
3. Neutral to Ground: 700 V
4. Line to Line: 1200 V

F. SCCR: Equal or exceed 100 kA.

G. I nominal Rating: 20 kA.

## 2.3 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R

## 2.4 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables.

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables.

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 0 519 Low-Voltage Electrical Power Conductors and Cables.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Install SPDs in all circuits serving life safety, and in all code-required emergency panels.

F. Wiring:

1. Power Wiring: Comply with wiring methods in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables.”
2. Controls: Comply with wiring methods in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables.”

### 3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

### 3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train the CHA's maintenance personnel to operate and maintain SPDs.

**END OF SECTION**

**SECTION 26 51 00**

**LED INTERIOR LIGHTING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior, solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation. Use the same designations as indicated on Drawings.

2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project; IES LM-79; and IES LM-80.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires, including, but not limited to all cove, coffer, and continuous linear run installations.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Provide separate shop drawing for each assembly configuration:
    a. Detailed drawings of continuous row linear recessed and suspended luminaires including dimensions, support spacing, suspension type, power feed type and locations, lamp combinations, driver locations, luminaire joint locations and end plates. Provide layout of sections fed from normal or emergency power, and locations of in-feeds. Provide separate feeds for normal and emergency sources.
    b. Detailed drawings for each cove and linear wall system configuration including dimensions, power feed locations, driver locations, luminaire joint locations, extension plates for end and corner sections and end plates. Provide layout of sections fed from normal or emergency power, and locations of in-feeds. Provide separate feeds for normal and emergency sources.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Exposed structural members to which luminaires will be attached.

5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

    a. Other luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Ceiling-mounted projectors.

7. Moldings and soffits.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of luminaire.

D. Product Test Reports: For each type of luminaire, for tests performed by a qualified testing agency.

E. Sample warranty.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide cutsheets for all fixtures, including information on replacement parts.
2. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.
3. Provide a list of approved cleaning solutions.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

## 1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

2. Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Fixture locations as indicated on the electrical drawings are generalized and approximate. Carefully verify locations with Architect’s plans, reflected ceiling plans and other reference data prior to installation. Check for adequacy of headroom and non-interference with other equipment, such as ducts, pipes or openings. Bring conflicts to the Architect’s attention before proceeding with the work.

C. Schedule the Work to prevent Work of this Section being damaged by other construction operations. Remove and replace Work so damaged at no cost to Owner.

D. Where Work of this Section is to be flush or concealed, install it to assure that it does not project beyond the finished lines of floors, ceilings or walls.

E. Verify ceiling system and furnish appropriate luminaire mounting accessories and trim needed for each fixture based on the ceiling type. Bring non-standard modifications necessary to comply with the Contract Documents and construction conflicts to the Architect’s attention before proceeding with Work.

F. Verify mounting conditions for all fixtures, and furnish appropriate mounting details including hangers, trim sets and other hardware as necessary to assure complete and Code compliant installation. Such mounting details shall be approved by Architect.

G. Coordinate locations of lighting fixtures and their supports with other Trades.

H. Catalog numbers might not reflect all necessary accessories and options. Provide all necessary accessories referenced, indicated or as-needed based on the review of architectural RCPs, interior elevations and actual field conditions for a complete and Code compliant installation.

I. Contractor shall verify each fixture type for all specific options as required for installation.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

C. Coverage: warranty shall cover LEDs, drivers, and color shift over time.

**PART 2 - PRODUCTS**

2.1 LUMINAIRE GENERAL REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, by a qualified testing agency, and marked for intended location and application.

B. Comply with local building and electrical codes.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. Comply with federal regulations as specified in EISA 2007.

2.2 LUMINAIRE SPECIFIC REQUIREMENTS

A. Refer to completed fixture schedule on Drawings for the following information:
1. Operating Voltage
2. Lamping information
3. CCT required
4. Minimum CRI
5. Finish.

6. UL Listing requirements for damp locations, wet locations, hazardous locations, or others.
7. Housing IP rating requirements, beyond IP20

B. Dimming luminaires shall operate from 100% to 1% light output.

C. Drivers shall be integral, unless noted otherwise in the fixture schedule.
1. Drivers shall be compatible with selected advanced digital lighting control system.

D. Heat sinks shall be integral, and not visible as part of the final installation.

E. LEDs and drivers shall have a minimum rate life of 50,000 hours.

F. Provide with integral mounting provisions or universal mounting bracket.

G. Provide with integral junction box with conduit fittings.

H. All luminaires shall be UL listed.

## 2.3 MATERIALS

A. Metal Parts:
1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.

C. Stainless Steel:

1. Manufacturer's standard grade.
2. Manufacturer's standard type, ASTM A240/240M.

D. Galvanized Steel: ASTM A653/A653M.

E. Aluminum: ASTM B209.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp characteristics:
a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.

c. CCT and CRI for all luminaires

H. Diffusers and Globes:

1. Diffuse glass, Clear glass, Prismatic acrylic, or Clear, UV-stabilized acrylic
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

## 3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps (if separate item) in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaires:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaires:

1. Ceiling Mount:

    a. Two diameter aircraft cable supports adjustable to 10 feet (3 m) in length
    b. Pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length

2. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
4. Outlet boxes for recessed lighting fixtures shall be installed with maximum 6ft of flexible conduit from fixture to outlet box.

I. All luminaires shall be supported from building structure. No luminaire shall be supported from ducts, piping, or their support systems. Brace suspended luminaires installed near ducts or other constructions with solid pendants or threaded rods.

J. Remote Mounting of Drivers: Distance between the driver and fixture shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire. Provide condition appropriate NEMA enclosure for locations where remote drivers are not specified with manufacturer's enclosure.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

## 3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

## 3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."

B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect or Lighting Designer.

**END OF SECTION**

**SECTION 26 52 13**

**EMERGENCY AND EXIT LIGHTING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Emergency lighting.
2. Exit signs.
3. Materials.
4. Luminaire support components.

### 1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.

B. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products and complying with applicable IES testing standards.

B. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

**PART 2 - PRODUCTS**

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the CEC, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

## 2.2 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Lighting Unit:
1. Emergency Lighting Unit: as indicated within Luminaire Schedule.
2. Operating at nominal voltage of 120 V ac or 24 V dc.
3. Wall with universal junction box adaptor.
4. City of Chicago compliant metal housing, rated for damp locations as needed.
5. Two LED lamp heads.
6. Internal emergency power unit.
   - Battery: Sealed, maintenance-free, nickel-cadmium type.
   - Charger: Fully automatic, solid-state, constant-current type.
   - Housing: NEMA 250, Type 1 enclosure
   - Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   - LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   - Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
   - Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.3 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction. City of Chicago compliant housing, letters, and background.

B. Internally Lighted Signs:
1. Operating at nominal voltage of 120 V ac or 24Vdc
2. Lamps for AC Operation:
   a. LEDs; 50,000 hours minimum rated lamp life.

## 2.4 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

2.5 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

## 3.5 STARTUP SERVICE

A. Perform startup service:
1. Charge emergency power units minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.

a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

**END OF SECTION**

**SECTION 26 56 19**

**LED EXTERIOR LIGHTING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Luminaire types.
2. Materials.
3. Finishes.
4. Luminaire support components.

### 1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

## 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all acceptable cleaning solutions.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: **5** year(s) from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, by a qualified testing agency, and marked for intended location and application.

B. Comply with local building and electrical codes.

C. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

E. Source Limitations:

1. Obtain luminaires from single source from a single manufacturer.
2. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

## 2.2 LUMINAIRE SPECIFIC REQUIREMENTS

A. Refer to completed fixture schedule on Drawings for the following information:
1. Operating Voltage
2. Lamping information
3. CCT required
4. Minimum CRI
5. Finish.
6. UL Listing requirements for damp locations, wet locations, hazardous locations, or others.
7. Housing IP rating requirements
8. Mounting type
9. Photometric distribution type
10. Finishes

B. Dimming luminaires shall be dimmable from 100% to 5% (maximum minimum threshold) of maximum light output.

C. Drivers shall be integral, unless noted otherwise in the fixture schedule.
1. Drivers shall be compatible with selected advanced digital lighting control system.

D. Heat sinks shall be integral, and not visible as part of the final installation.

E. LEDs and drivers shall have a minimum rate life of 50,000 hours.

F. Provide with integral mounting provisions or universal mounting bracket.

G. Provide with integral junction box with conduit fittings.

H. All luminaires shall be UL listed, Comply with UL 1598, and listed for wet location.

I. Lamp base complying with ANSI C81.61 or IEC 60061-1.

J. Bulb shape complying with ANSI C79.1.

K. L70 lamp life of 50,000 hours or greater.

L. In-line Fusing: Separate in-line fuse for each luminaire

M. Lamp Rating: Lamp marked for outdoor use

2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum or Stainless steel. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. LED Housings:

a. Extruded-aluminum housing and heat sink.
b. Clear anodized, or powder-coat painted finish. Refer to schedules.

I. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.

b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

a. Color: as indicated on plans.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color:

1) As selected from manufacturer's standard catalog of colors.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, canopy ceilings, and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or Attached to a minimum 1/8 inch (3 mm) backing plate attached to wall structural members

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

## 3.4 INSTALLATION OF BOLLARD LUMINAIRES

A. Align units for optimum directional alignment of light distribution, or as indicated on plans.

## 3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

## 3.6 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

## 3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

## 3.8 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

**END OF SECTION**

**SECTION 27 00 00**

**GENERAL COMMUNICATIONS REQUIREMENTS**

## PART 1 - GENERAL

1.1 SCOPE

A. This section details references, standards, guidelines, requirements and conditions common to all Division 27 work.

B. Work under this Section and related sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.

1.2 DESCRIPTION

A. Intent of drawings and specifications is to obtain complete systems tested, adjusted, and ready for operation.

B. Except as otherwise defined in greater detail, terms "provide", "furnish" and "install" as used in Division 27 contract documents shall have the following meanings:

1. "Provide" or "provided" shall mean "furnish and install".
2. "Furnish" or "furnished" does not include installation.
3. "Install" or "installed" does not include furnishing.

C. Include incidental details not usually shown or specified, but necessary for proper installation and operation.

D. Check, verify and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations or adjustments necessary to complete work or to avoid interference with other trades.

E. Included in this contract are connections to equipment provided by others. Refer to Architectural, Electrical, Integrated Automation, Mechanical, Security and final shop drawings for equipment being furnished under other sections for exact locations of outlets and various connections required.

F. Information given herein and on drawings is as exact as could be secured but is not guaranteed. Do not scale drawings for exact dimensions.

G. Where architectural features govern location of work, refer to architectural drawings.

H. All work shall be performed in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".

I. Temporary Services:

1. Refer to Division 01 - Temporary Facilities and Controls.

J. Continuity of Service:

1. No service shall be interrupted or changed without permission from Architect and Owner. Obtain written permission before work is started.
2. When interruption of services is required, persons concerned shall be notified and shall agree upon a time.

K. Demolition:

1. Division 01 - Selective Demolition.

a. Not applicable to this Division of work.

2. Division 02 - Building Demolition

a. Not applicable to this Division of work.

3. Perform demolition as required to accomplish new work.

a. Remove abandoned wiring to source of supply.

b. Disconnect abandoned outlets and remove devices.

c. Remove abandoned outlets if conduit servicing them is abandoned and removed.

d. Provide blank cover for abandoned outlets that are not removed.

e. Disconnect communications systems in walls, floors, and ceilings scheduled for removal.

4. Verify with PM requirement of inclusion of demolition drawings.
5. Accomplish work in neat workmanlike manner to minimize interference; annoyance or inconvenience such work might impose on Owner or other contractors.
6. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
7. Equipment noted to be removed and turned over to Owner shall be delivered to Owner at place and time Owner designates.
8. Where materials are to be turned over to Owner or reused and installed by Contractor, it shall be Contractor's responsibility to maintain condition of materials and equipment equal to that existing before work began. Repair or replace damaged materials or equipment at no additional cost to Owner.
9. Where demolition work interferes with Owner's use of premises, schedule work through Architect, Owner and with other contractors to minimize inconvenience to Owner. Architect must approve schedule before Contractor begins such work.

L. Cleaning and Repair

1. Clean and repair existing materials and equipment that remain or is to be reused.

M. Concrete Work:

1. Provide cast-in-place concrete as required by contract documents unless otherwise noted.
2. Concrete shall comply with Division 03 - Concrete.
3. Provide anchor bolts, metal shapes and templates required to be cast in concrete or used to form concrete for support of equipment.

N. Painting:

1. Furnish equipment with factory applied prime finish unless otherwise specified.
2. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment to satisfaction of Engineer.
3. Furnish one can of touch up paint for each factory finish, which will be final finished surface of product.
4. Contractor is responsible for painting of plywood in Telecommunications Equipment Rooms. Refer to Drawings.

## 1.3 REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State and local authorities and utility companies, in force at time of execution of contract shall become part of this specification.

## 1.4 REFERENCES AND STANDARDS

A. Design, cable and component selection, and installation practices shall conform with following:

1. ANSI/Chicago Electrical Code
2. Local Electrical Code
3. Country, state and local health, safety and building codes
4. UL 444 - Communications Cables
5. Standards identified in individual Technical Sections.
6. BICSI Telecommunications Distribution Methods Manual (TDMM)
7. TIA 568.0-D through.4-D - Commercial Building Telecommunications Cabling Standard (including applicable Addenda)
8. TIA 569-D - Commercial Building Standard for Telecommunications Pathways and Spaces
9. Chicago Housing Authority standards and procedures for facility maintenance, construction, and IT services.

B. Agencies or publications referenced herein refer to the following:

1. ANSI..... American National Standards Institute
2. ASME..... American Society of Mechanical Engineers
3. ASTM..... American Society for Testing and Materials

4. BICSI..... Building Industry Consulting Services International
5. EIA ..... Electronic Industries Alliance
6. FIPS..... Federal Information Processing Standards
7. FCC ..... Federal Communications Commission
8. ICEA..... Insulated Cable Engineers Association
9. IEEE .....Institute of Electrical and Electronics Engineers
10. CEC .....Chicago Electrical Code
11. NECA..... National Electrical Contractors Association
12. NEMA..... National Electrical Manufacturers Association
13. NESC..... National Electrical Safety Code
14. NETA ..... National Electrical Testing Association
15. NFPA..... National Fire Protection Association
16. NIST .....National Institute of Standards and Technology
17. OSHA ..... Occupational Safety and Health Administration
18. TIA ..... Telecommunications Industry Association
19. UL..... Underwriters Laboratories, Inc.

C. Work shall be in accordance with latest edition of codes, standards or specifications unless noted otherwise.

1.5 DEFINITIONS

A. The following definitions are applicable to communications environments and shall apply to this document and its companion sections for clarification and direction.

1. Entrance facility - an entrance to building for both public and private network service cables and/or wireless services including entrance point of building and continuing to Entrance Room.
2. Entrance Room - room where both public and private network service cables and/or wireless services are terminated. Service provider(s) point-of-demarcation (DEMARC) is typically located here.
3. Equipment Room (Telecom): an environmentally controlled centralized space for telecommunications equipment that usually houses main or intermediate cross-connect. Backbone cabling, cabling to Building Entrance and horizontal cabling may be terminated here.
4. Guarantee - promise or an assurance that attests to quality or durability of product or service or that task will be performed in specified manner. Used interchangeably with "Warranty" in these documents.
5. Intra-building - within single building.
6. Inter-building - between 2 or more buildings.
7. IP Telephony – Use of Internet Protocol (IP) for two-way transmission of conversations. Sometimes referred to as “Voice over Internet Protocol (VoIP)”.
8. Rack Unit - standard measurement of vertical mounting space on an equipment rack. Each Rack Unit is 1-3/4” high.
9. Voice over Internet Protocol – Refer to IP Telephony.

B. Typical NEMA Enclosures and Usage

1. Refer to Section 26 0000 – General Electrical Requirements.

2. NEMA 1 - Indoors. Falling dirt
3. NEMA 2 - Indoors. Falling dirt. Falling liquids. Light splashing
4. NEMA 3 - Outdoors. Sleet, snow, rain. Windblown dust
5. NEMA 3X - Same as NEMA 3 plus corrosion resistant
6. NEMA 3S - Same as NEMA 3 plus mechanism operable when ice covered
7. NEMA 3SX - Same as NEMA 3S plus corrosion resistant
8. NEMA 3R - Outdoors. Rain, snow, sleet
9. NEMA 3RX - Same as NEMA 3R plus corrosion resistant
10. NEMA 4:

    a. Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down

    b. Outdoors - Rain, sleet, snow. Wind-blown dust. Hose down

11. NEMA 4X - Same as NEMA 4 plus corrosion resistant
12. NEMA 5 - Indoors. Falling Dirt. Falling Liquids. Settling dust, lint and fibers
13. NEMA 6:

    a. Indoors - Falling dirt. Falling and light splashing liquids. Flying dust, lint and fibers. Hose down. Temporary submersion.

    b. Outdoors - Rain, snow, sleet. Windblown dust. Hose down. Temporary submersion.

14. NEMA 6P:

    a. Indoors - Same as NEMA 6 / Indoors plus corrosion resistant. Prolonged submersion.

    b. Outdoors - NEMA 6 /Outdoors plus corrosion resistant. Prolonged Submersion.

15. NEMA 7 - Indoors. Class I, Division 1 or 2, Groups A, B, C or D. (Flammable gas).
16. NEMA 9 - Indoors. Class II, Division 1 or 2. Groups E, R, or G. (Combustible dust).
17. NEMA 12 - Indoors. Falling Dirt. Falling liquids. Flying dust, lint and fibers. Oil or coolant seepage.
18. NEMA 13 - Same as NEMA 12 plus oil or coolant spraying or splashing.

## 1.6 ABBREVIATIONS AND ACRONYMS

A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

1. AFF..... Above Finished Floor
2. AP..... Access Point (see WAP)
3. ATM..... Asynchronous Transfer Mode
4. AWG ..... American Wire Gauge

5. BAS ..... Building Automation Systems
6. BTU..... British Thermal Unit
7. CATV..... Community Antenna Television
8. CCTV ..... Closed-Circuit Television
9. cm..... centimeters
10. °C..... degrees Celsius
11. °F ..... degrees Fahrenheit
12. DTMF..... Dual Tone Multi Frequency
13. DEMARC..... Demarcation Point (for Service Provider connections)
14. EIA ..... Electronic Industries Alliance
15. EF ..... Entrance Facility
16. ER..... Entrance Room
17. FDDI..... Fiber Distributed Data Interface
18. ft ..... feet
19. GbE..... Gigabit Ethernet
20. Hz ..... Frequency in Hertz (k = kilo, M = Mega, G = Giga)
21. ID..... Inside Diameter
22. IDF ..... Intermediate Distribution Frame
23. in..... inch
24. IP ..... Internet Protocol
25. lbs ..... pounds
26. LAN..... Local Area Network
27. MATV ..... Master Antenna Television
28. MC..... Main Cross-connect
29. MDF ..... Main Distribution Frame
30. m..... meters
31. mm..... millimeters
32. Mbps..... Megabits per second
33. µm ..... micrometer (10-6 meter)
34. OD ..... Outside Diameter
35. pF..... pico-Farad (10-12 Farad)
36. PVC ..... Polyvinyl Chloride
37. RU ..... Rack Unit
38. SP ..... Service Provider
39. sq. ft ..... square feet (area)
40. WAN ..... Wide Area Network
41. WAP..... Wireless Access Point
42. WLAN..... Wireless Local Area Network
43. VoIP ..... Voice over Internet Protocol

B. Refer also to technical sections for additional terminology.

1.7 LISTING

A. Refer to technical sections of this Division of work for listing requirements.

1.8 SUBMITTALS

A. Submit shop drawings for equipment provided under this Section:

1. Refer to Division 01 - Submittal Procedures.
2. Note that for satisfying submittal requirements for Division 27, "Product Data" is usually more appropriate than true "Shop Drawings" as defined in Division 01. However, expression "Shop Drawings" is generally used throughout specification.
3. Mark catalog sheets and drawings to indicate specific items submitted. Markings shall be reproducible (arrow, boxed, encircled, checkmark, etc.). Where sheet includes multiple product options, mark proposed option(s).
4. Include proper identification of equipment by name and/or number, as indicated in specification and shown on drawings.
5. When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. Mark and annotate submittals accordingly.
6. Group submittals by Section to include complete documentation of related systems, products and accessories. Where applicable, dimensions shall be marked in units to match those specified.
7. Submittals shall be in electronic form or on paper per Division 01. Documents in electronic form shall be ADOBE *Acrobat* PDF. Paper documents shall be original catalog sheets or photocopies thereof. Facsimile (fax) sheets will not be accepted.
8. Engineer’s Review is to confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that all required items have been submitted.
9. When equipment and items specified include accessories, parts and additional items under one designation, submittals shall be complete and include required components.
10. Include wiring diagrams for electrically powered or controlled equipment.
11. Submit equipment room layouts drawn to scale, including equipment, raceways, accessories and clearance for maintenance.
12. Where submittals cover products containing potentially hazardous non-metallic materials, include "Material Safety Data Sheet" (MSDS) from manufacturer stating physical and chemical properties of components and precautionary considerations required.
13. Submit shop drawings or product data as soon as practicable after signing contracts. Submittals must be approved before installation of materials and equipment.
14. Submittals, which are not complete, not permanent, or not properly checked by Contractor, will be returned without review.
15. "Coordination Drawings", which are normally prepared by Contractor to coordinate work among various trades and to facilitate installation, shall not be submitted for Division 27 work unless specifically requested in technical sections. These types of drawings typically include dimensioned piping, ductwork, communications and/or electrical raceway layouts.

    a. Unless specifically requested in Division 27 technical sections, submittals of coordination drawings will be returned without review.

B. Certificates and Inspections:

1. Obtain and pay for inspections required by authorities having jurisdiction and deliver certificates approving installations to Owner unless otherwise directed.

C. Operation and Maintenance Manuals:

1. Refer to Division 01 - Operation and Maintenance Data.
2. Upon completion of work but before final acceptance of system, submit to Architect for approval, 3 copies of operation and maintenance manuals in loose-leaf binders. If "one copy" is larger than 2" thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit 3 copies to Owner.
3. Manuals shall be organized by specification section number and shall have table of contents and tabs for each piece of equipment or system.
4. Manuals shall include the following:

    a. Copies of shop drawings

    b. Manufacturer's operating and maintenance instructions. Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.

    c. CD ROM's of O&M data with exploded parts lists where available

    d. Phone numbers and addresses of local parts suppliers and service companies

    e. Internet/WEB page addresses where applicable

    f. Wiring diagrams

    g. Start up and shut down procedure

    h. Factory and field test records

    i. Additional information, diagrams or explanations as designated under respective equipment or systems specification section

5. Instruct Owner's representative in operation and maintenance of equipment. Instruction shall include complete operating cycle on all apparatus.
6. O&M manuals and instructions to Owner shall be provided prior to request for final payment.

D. Record Documents:

1. Refer to General Conditions of Contract, and Division 01 - Closeout Procedures. Prepare complete set of record drawings in accordance with Division 01.
2. Use designated set of prints of contract documents as prepared by Architect to mark-up for record drawing purposes.

1.9 JOB CONDITIONS

A. Building Access:

1. Arrange for necessary openings in building to allow for admittance of all apparatus.

B. Cutting and Patching:

1. Refer to General Conditions of Contract, and Division 01 - Cutting and Patching.
2. Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore work cut or damaged, to original condition. This includes openings remaining from removal or relocation of existing system components.
3. Provide materials required for patching unless otherwise noted.
4. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.
5. Where alterations disturb lawns, paving, walks, etc., replace, repair or refinish surfaces to condition existing prior to commencement of work. This may include areas beyond construction limits.

C. Housekeeping and Cleanup:

1. Refer to Division 01 - Closeout Procedures.
2. Periodically as work progresses and/or as directed by Architect, remove waste materials from building and leave area of work broom clean. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from site.

1.10 WORK BY OWNER

A. Owner or Owner's Agent will provide:

1. Active electronics for interface with building voice and data cabling systems
2. Connections from telephone and data equipment to Contractor provided cabling.
3. Connections from Backbone Voice Cables to Horizontal Voice Cables.
4. Passive Broadband distribution hardware (coaxial cable taps and splitters)
5. Active Broadband headend and distribution hardware (video processing, distribution amplifiers, etc.)

1.11 QUALITY ASSURANCE

A. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, and contractor qualifications and certification requirements.

1.12 GUARANTEE

A. Refer to Division 01 for general Guarantee (Warranty) requirements.

B. Refer to technical sections for Guarantee requirement for each system.

1. Where no guarantee requirements are called out, guarantee for one year after acceptance by Owner equipment, materials, and workmanship to be free from defect.

C. Repair, replace or alter systems or parts of systems found defective at no extra cost to Owner.

D. Wherein fulfilling requirements of any guarantee, if Contractor disturbs any work guaranteed under another contract, restore such disturbed work to condition satisfactory to Architect and guarantee such restored work to same extent as it was guaranteed under such other contract.

E. Guarantees shall include labor, material and travel time.

**PART 2 - PRODUCTS**

2.1 PRODUCT SUBSTITUTIONS

A. Refer to Division 01 - Product Requirements.

**PART 3 - EXECUTION**

3.1 GENERAL

A. Verify elevations and measurements prior to installation of materials.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Store in clean, dry space.

D. Maintain factory wrapping or provide cover to protect units from dirt, water, construction debris, and traffic.

E. Handle in accordance with manufacturer's written instructions.

F. Handle carefully to avoid damage to components, enclosure, and finish. Lift only with lugs provided for the purpose.

3.3 FLOOR, WALL, ROOF AND CEILING OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.

B. Temporary sleeves, if used to form wall openings, shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24 ga. galvanized sheet metal unless otherwise noted.

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. For core drilled holes, size and location shall be reviewed and approved by Structural Engineer prior to execution.

E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.

G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by the structural engineer prior to preparing openings in structural member.

H. Openings for penetrations shall be minimum 1/2” larger on all sides than outside dimensions of raceways or cables. However, where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

J. Seal non-rated wall openings with urethane caulk.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation or sealing system by another manufacturer approved as equal by Architect. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

L. Finish and trim penetrations as shown on details and as specified hereinafter.

## 3.4 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to equipment for maintenance. Relocation of raceways, or accessories as required to provide access, shall be provided at no additional cost to Owner.

B. Install equipment with ample space allowed for removal, repair or changes to equipment. Provide ready accessibility to equipment and wiring without moving other equipment, which is to be installed or which is already in place.

C. Access doors in walls, chases, or inaccessible ceilings will be provided under Division 08 - Access Doors and Frames, unless otherwise indicated. Access doors shall be for purpose of providing access where equipment requiring servicing, repairs or maintenance is located in walls, chases or above inaccessible ceilings.

D. Provide necessary coordination and information to Trade Contractor under Division 08 - Access Doors and Frames. This information shall include required locations, sizes and rough-in dimensions, without limitations.

E. Provide access doors where equipment, requiring access for servicing, repairs and maintenance is located in walls, chases or above inaccessible ceilings, unless otherwise noted. Access frames and doors shall be as manufactured by Milcor, Incorporated, or similar, of style applicable to surface. Access doors used in fire-rated construction shall have UL label. Access doors shall be steel, prime coated, except use stainless steel doors in ceramic tile walls, toilet rooms, locker rooms, and in areas subject to excessive moisture. Access doors shall be of sufficient size to allow for total maintenance. Location of access doors shall be coordinated with General Contractor and location of equipment shall be roughed in accordingly.

F. Locate communications outlets and equipment to fit details, panels, decorating or finish at space. Architect reserves right to make minor position changes of outlet locations before work has been installed.

G. Verify room door swings before installing wall-mounted communications outlets and install boxes on latch side of door unless otherwise noted.

## 3.5 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

B. Concrete anchors, used for attachment to concrete, shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

## 3.6 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

B. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.

C. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

## 3.7 CABLE PROTECTION

A. Protect cabling and termination components from contact with, and potential application of, foreign materials.

1. Foreign material is defined as material that is not part of cabling assembly and termination components when delivered from manufacturer.
2. Examples include paint overspray and drywall compound.

B. Cabling and components that come into contact with foreign materials shall be replaced at no cost to project.

1. Solvents and other cleaning agents shall not be used to remove foreign materials that have already accumulated on cabling and components.

## 3.8 ACCEPTANCE TESTING

A. Prior to testing, submit to owner (or Owner's representative) and Engineer, proposed schedule for acceptance testing.

1. This notification shall be minimum of 10 working days in advance to allow for participation by Owner and/or Engineer.

B. Prior to testing, submit written description of intended test procedures and submit sample test forms to Engineer.

1. Submitted information shall include proposed file naming format to be used in identifying cable, pair or optical fiber which is subject of test record.
2. Failure to provide above information shall be grounds for Engineer or Owner to reject any Documentation of related testing and to require repeat of affected test.

C. Conduct tests during course of construction when identifiable portion(s) of installation is complete.

1. Alternatively, testing can be conducted after entire installation is complete if this does not delay project schedule.

D. Provide equipment and personnel necessary to conduct acceptance tests.

E. Testing shall be completed and accepted by Owner and Engineer before Owner furnished equipment and cross connects are installed.

F. Document tests.

G. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary and repeat inspection and test. This shall be at no additional cost to the owner. Replacement materials shall be new.

H. This Contractor is responsible for certifying, in writing, equipment and system test results. Certification shall include identification of portion of system tested, date, time, test criteria and name and title of person signing test certification documents.

I. Maintain copies of certified test results, including those for failed tests, at project site. At completion of project, include copies of test records and certifications in O&M Manuals.

## 3.9 START-UP

A. All systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation.

1. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/installer knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with trades.

## 3.10 DOCUMENTATION

A. Upon completion of installation, Contractor shall provide System Documentation. Documentation shall include:

1. Acceptance Test Results
2. Record Drawings
3. All Approved Submittals
4. Manufacturer’s Warranty Documents

B. Submit System Documentation in accordance with Division 01 "Project Record Documents".

1. Documents shall be submitted in same electronic format in which they were received from Architect and Engineer.
2. Document updates shall be performed in native software format matching original design team documents.
   Scans of hand marked documents shall not be allowed.
3. Update documents to reflect installed conditions for equipment shown on documents.

C. Submit documentation within ten (10) working days of the completion of testing of each testing phase (e.g. subsystem, cable type, area, floor, etc.) or 3 weeks prior to scheduled occupancy of subject area, whichever is sooner. This is inclusive of Test Result and draft Record Drawings.

1. Draft drawings may include mark-ups done by hand.
2. Machine generated (final) copies of Record Drawings shall be submitted within 30 working days of completion of each testing phase.
3. Documentation will include all aspects of systems covered by these specifications that are required for systems to be fully functional.
4. For structured cabling this includes the horizontal link from the TO to the HC, backbone cabling from the HC to the MC, cross-connections, interconnections and/or patch cords that are the responsibility of the contractor.

D. Submit Acceptance Test Results in electronic form for review and distribution.

1. Interim documentation of Test Results (if applicable) may be submitted via email or on CD-ROM.
2. Final documentation of Test Results shall be submitted on CD-ROM.
3. Test results shall be submitted in format(s) native to test instrument(s) used in performing testing.
4. Where unique software (other than an MS-Word® compatible Word Processor or MS-Excel® spreadsheet) is required for viewing of test results, Contractor shall provide along with above documentation, **1** licensed copy of such software. Software shall run on MICROSOFT Windows-based personal computer.

E. Acceptance Test results shall include description of sub-system tested, equipment/cable/outlet I.D., reference and test setup, test equipment type/model and serial number(s), equipment location and direction of test (if applicable), test frequencies/wavelengths, date and operator name(s).

F. Engineer or Owner may request that 10% random re-test be conducted on cable system - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in technical sections.

1. Owner may also perform independent testing to verify results.
2. If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.

G. Documentation - including hard copy and electronic forms of Test Data and Record Drawings - shall become property of Owner.

H. Refer also to Technical Sections for requirements specific to covered subsystems.

3.11 CLEANING

A. After installation is complete, Contractor shall clean all systems.

B. Vacuum debris from system components, enclosures, junction boxes and pull boxes prior to testing and again prior to completion.

C. Thoroughly clean equipment of stains, paint spots, dirt and dust. Remove temporary labels not used for instruction or operation.

**END OF SECTION**

**SECTIONS 27 05 53**

**COMMUNICATIONS SYSTEMS IDENTIFICATION**

## PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for labeling of communications cabling, termination components, pathways and spaces for Communications Systems.

1.2 DESCRIPTION

A. All components shall be clearly labeled to identify them as unique throughout the project.

B. Labeling requirements include identification of Rooms, Equipment Racks, Telecommunications Outlets, Horizontal and Backbone Cabling, Termination Hardware (Patch Panels, Blocks) and Grounding.

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 1500 - Communications Horizontal Cabling

B. Related sections in other Divisions of Work:

1. Refer to individual technical sections identified above (if applicable).

1.4 REFERENCES AND STANDARDS

A. Refer to Section 270000 - General Communications Requirements which identifies pertinent References and Standards.

B. Other applicable references and standards include:

1. TIA/EIA-606-C - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

1.5 DEFINITIONS

A. Refer to Section 270000 - General Communications Requirements which provide information on Definitions used in this and related sections.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 270000 - General Communications Requirements which provide information on Abbreviations and Acronyms used in this and related sections.

1.7 WORK BY OWNER

A. Refer to Section 270000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 270000 - General Communications Requirements which provide general guidelines for product and/or installation information to be submitted by contractor.

B. Prior to installation, provide samples of label types planned for the project.

1. Samples shall include examples of lettering to be used and shall follow standards detailed below.

1.9 QUALITY ASSURANCE

A. Refer to Section 270000 - General Communications Requirements which identifies general quality assurance requirements for the project.

**PART 2 - PRODUCTS**

2.1 GENERAL

A. Labels and markings shall be physically and chemically resistant to damage that would make label unreadable.

B. Cable labels shall be self-laminating, White/Transparent Vinyl (or other substrates facilitating easy application and flex as cables are bent) and incorporate an integrated clear lamination which covers printed part of label when label is wrapped around cable.

1. If cable jacket is white, provide cable label with printing area that is a color other than white to easily distinguish label from cable jacket.
2. Labels shall be of adequate size to accommodate circumference of cable(s) being marked and properly self-laminate over full extent of printed area of label.
3. Labels on larger cables (e.g. Copper Backbone) may be wrapped with clear non-removable tape.

C. Labels shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing. Tags shall be non-removable.

1. Exceptions:

    a. Telecommunications Outlet labels that are placed in recessed label holders.
    b. Telecommunications Ground tags secured with cable ties.
    c. Innerduct Tags secured with cable ties.

D. Labels for 110-type Termination Blocks shall be Color-coded to indicate the cable type (inter-building, intra-building backbone, horizontal, etc.). Refer to Part 3.

**PART 3 - EXECUTION**

3.1 GENERAL

A. Labeling shall be by mechanical means.

1. Hand lettered designations are not allowed.

B. Tags shall be non-removable.

1. Exceptions:

    a. Telecommunications Outlet labels that are placed in recessed label holders.
    b. Telecommunications Ground tags secured with cable ties.
    c. Innerduct Tags secured with cable ties.

C. Characters shall be Black Ink and printed on background of contrasting color.

D. Labels shall match hardware layout and design.

E. Labels shall be as large as practicable while fitting properly.

F. No lettering shall be smaller than 10-point.

G. Label cables with tag which is wrapped around cable sheath.

1. Clean cable sheath thoroughly before applying label.
2. Labels shall not be obscured by termination hardware.

3.2 ROOM IDENTIFICATION

A. Label Communications Backboard or Equipment Rack or Panel closest to entry door with unique identifying code.

B. Characters shall be 1” minimum.

C. Room ID shall be the Architectural numbering scheme.

3.3 EQUIPMENT RACK IDENTIFICATION

A. Label each Equipment Rack or wall-mounted Panel with unique identifying code as follows:

1. TR-##, where:

a. "TR" is identifier for room where rack is located
b. "##" is sequential letter for rack starting at "A".

B. Position Labels at top of rack or on exterior of panel.

C. Characters shall be 1-inch minimum.

3.4 TELECOMMUNICATIONS OUTLET

A. Label each Telecommunications Outlet (TO) connector with unique identifying code.

B. Telecommunications Outlet connector numbering shall result in logical numbering sequence in work area.

1. Labeling plans that results in random TO numbering in work area are not acceptable.

C. Place Faceplate labels on outside of cover.

D. Position Labels in recessed label holders on faceplate and covered with clear plastic covers.

1. Where Communications Outlet Faceplates not incorporating recessed holders are allowed, faceplate labels shall be protected with clear laminate.

E. Telecommunications Outlet labeling code shall be as follows:

1.01 Owner LAN and WLAN cabling:

a. TR-RPP-##, where:
1. “TR” is identifier for room where cable terminates in horizontal cross-connect.

b. “R” is identifier for Equipment Rack, Panel or Termination Block where cable terminates
1. Alpha character starting at “A”.

c. "PP" is Patch Panel on which cable is terminated at HC.
1. Number starting at “01”.
1) Panel numbering shall be from Top (of Rack) to Bottom.

d. "##" is sequential POSITION of Jack on Panel
1. 1 - 48 is typical
1) Position sequence shall be Left-Right and Top-Bottom.

e. Example: "3W-A03-25" represents 25th Jack Position in 3rd Panel on Equipment Rack “A” in Telecom Room "3W".

1. Faceplate labels can use common TR identifiers on each label strip. For example, two data jacks served from TR 3W sharing common label strip may be represented by:

| 3W | |
|---|---|
| A01-25 | A01-26 |

2. Residential Unit Voice and Coaxial

a. TR-RU-##, where:

1) “TR” is identifier for room where cable terminates in horizontal cross-connect.

2) “RUI” is the identifier for the individual Residential Unit number where the far end of cable terminates.

3) “##” is the identifier for the cable within the residential unit. Cables shall be identified by location to the entry door, starting at entry door, from left to right in a clockwise manner. Numbers shall start at “01”.

4) Example: “3W-301-02” represents the second jack in Unit 301 and cable originates in TR 3W.

## 3.5 HORIZONTAL CABLING

A. Label each horizontal cable at Telecommunications Outlet and at horizontal cross-connect with unique identifying code.

B. Cable shall be labeled at both ends within 4" of cable choke (end of jacket).

C. Horizontal labeling code shall be same as identified for Telecommunications Outlet above.

## 3.6 MODULAR PATCH PANEL

A. Label each patch panel and port at horizontal cross-connect with unique identifying code.

B. Patch panel labeling code shall be same as identified for Telecommunications Outlet above.

1. Label Panel I.D.

a. Panel numbering shall be from Top to Bottom

2. Label Individual Port I.D.

a. Port I.D. shall be from Left to Right, Top to Bottom.

b. Manufacturers port labeling is acceptable.

C. Room number is not required on modular patch panels.

D. Equipment Rack number is not required on modular patch panels.

3.7 BACKBONE COPPER CABLE

A. Label each backbone cable at both ends at termination point with unique identifying code.

B. Label cable sheath:

1. At point where sheath ends
2. At point on cable where viewing of label is not obscured by termination blocks or other visual barrier.

C. Label shall be on plastic tag tie-wrapped to cable sheath or placed on adhesive labels adhered to cable sheath.

1. If adhesive labels are used, place clear plastic tape over label to protect it and maintain adhesion to sheath.

D. Label Intra-building cables with:

1. From and to locations,
2. Pair numbers

a. Where multiple cables are installed between same end-points, labeling shall indicate sequential pair numbering.
1. For example 400-pair provided as two 200-pair cables would be labeled "001-200" and "201-400".

3. Date installed.

a. Example 200-pair cable from ER106 to TR3164 installed October 2009:

| ER106-TR3164 |
| --- |
| 001-200 |
| 10/2009 |

3.8 TERMINATION BLOCKS

A. Provide color-coded designation strips with Termination Blocks.

B. Label termination positions on designation strips with position identifier.

C. Horizontal Cabling Blocks shall incorporate BLUE Designation Strips and shall identify:

1. Telecommunications Outlet / Jack I.D.s for all Voice cabling for residential units

D. Intra-Building (within building) Backbone Cabling Blocks shall incorporate WHITE Designation Strips.

1. Label Designation Strips with:

    a. Cable Origin & Destination

1. Repeat on every designation strip.

    b. Pair Count.

1. Label 1st and 25th Positions on each row (e.g. 001 & 025, 026 & 050, etc.).

2. Example ER106 to TR3164:

| | | |
|---|---|---|
| 001 | ER106-TR3164 | 025 |
| 026 | ER106-TR3164 | 050 |

E. Feed Blocks (from Access/Service Provider) shall incorporate GREEN Designation Strips.

1. Label Designation Strips with:

    a. Designation as "FEED CABLE"
    b. Pair Count.

2. Example (Verizon as Service Provider):

| | | |
|---|---|---|
| 1201 | FEED (VERIZON) | 1225 |
| 1226 | FEED (VERIZON) | 1250 |

3.9 BACKBONE FIBER OPTIC CABLING

A. Label each backbone cable at both ends at termination point with unique identifying code.

B. Label shall be placed on adhesive labels adhered to cable sheath.

C. Label Intra-building cables with:

1. From and to locations,
2. Fiber type (core/cladding diameter)
3. Fiber count

    a. Where multiple cable is installed between same end-points, labeling shall indicate sequential fiber numbering.
    1. For example, 144-fibers provided as two 72-fiber cables would be labeled "001-072" and "073-144".

4. Date installed.
5. Example 72-fiber cable from ER106 to TR3164 installed October 2009:

| ER106-TR3164 |
| --- |
| 50/125 001-072 |
| 10/2009 |

D. Label Inter-building cables with:
   1. From and to locations,
   2. Fiber type (core/cladding diameter)
   3. Fiber count

      a. Where multiple cable is installed between same end-points, labeling shall indicate sequential fiber numbering.
      1. For example, 144-fibers provided as two 72-fiber cables would be labeled "001-072" and "073-144".
   4. Date installed.
   5. Example 72-fiber cable from Building 108 ER to Building 110 ER installed October 2009:

| ER108-ER110 |
| --- |
| 50/125 001-072 |
| 10/2009 |

3.10 FIBER OPTIC PATCH PANELS

A. Label each fiber coupling in patch panel or workstation outlet with unique identifying code.

B. Patch panel labels shall be visible from front of panel without opening panel cover.

C. Place labels in manufacturer designated labeling areas.

D. Label Fiber Optic Patch Panels with unique labeling code to identify:

   1. Cable Destination
   2. Fiber type (core/cladding diameter)
   3. Fiber (or coupler) number of each panel position.

      a. Port I.D. shall be from Top to Bottom, Left to Right,
      b. Manufacturers port labeling is acceptable.

E. Room number is not required on fiber optic patch panels.

F. Equipment Rack number is not required on fiber optic patch panels.

3.11 INNERDUCT

A. Innerduct containing fiber optic cable installed under this project shall be labeled where exposed.

1. Includes areas where innerduct is installed in trays and in equipment rooms.

B. Label innerduct with durable Yellow Polyethylene tag that reads "CAUTION FIBER OPTIC CABLE"

1. Tag shall provide blank spaces for adding fiber count and cable destination information.

C. Label Tag to include:

1. Identifier(s) of cable(s) contained therein.

a. Use Backbone Cable labeling formats as described above.

D. Hand lettering is acceptable on tag

1. Use an indelible type ink.

E. Tag shall be secured to Innerduct using self-locking ties.

3.12 TELECOMMUNICATIONS GROUNDS

A. Label Grounds as close as practicable to point of termination.

B. Labels shall be non-metallic and include the following:

| WARNING |
| --- |
| IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER. |

**END OF SECTION**

**SECTION 27 15 00**
**COMMUNICATIONS HORIZONTAL CABLING**

## PART 1 - GENERAL

1.1 SCOPE

A. This section details product and execution requirements for Horizontal (Station) Cabling subsystem for Communications Systems.

1.2 DESCRIPTION

A. Horizontal cabling subsystem is portion of communication link that connects horizontal or intermediate cross-connect (typically at Telecom Room) and Telecommunications Outlet.

B. Horizontal Cable types include:

1. 4-pair Copper Unshielded Twisted Pair (UTP)
2. Coaxial

1.3 RELATED WORK

A. Related Division 27 Sections include:

1. Section 27 0000 - General Communications Requirements
2. Section 27 0553 - Communications Systems Identification

B. Related sections in other Divisions of Work:

1. Refer to individual technical sections identified above (if applicable).

1.4 REFERENCES AND STANDARDS

A. Refer to Section 27 0000 - General Communications Requirements which identifies pertinent References and Standards.

1.5 DEFINITIONS

A. Refer to Section 27 0000 - General Communications Requirements which provide information on Definitions used in this and related Sections.

B. In this section, "Telecommunications Outlet" is considered to consist of Frame/Faceplate into which Modular Jacks or other couplings snap, Modular Jacks, blanks fitted to unused jack positions, and labeling/identification components.

1.6 ABBREVIATIONS AND ACRONYMS

A. Refer to Section 27 0000 - General Communications Requirements which provide information on Abbreviations and Acronyms used in this and related Sections.

1.7 WORK BY OWNER

A. Refer to Section 27 0000 - General Communications Requirements which identifies Work by Owner affecting sub-system(s) covered by this section.

1.8 SUBMITTALS

A. Refer to Section 27 0000 - General Communications Requirements which provide general guidelines for product or installation information to be submitted by Contractor.

B. In addition, submit:
   1. Samples of each Telecommunications Outlet Faceplate type to confirm color and material.
   2. One 3 ft section of each cable type from cable reels sent to site for Engineer's final approval.
      a. Section shall have manufacturer's cable markings visible.
   3. Nominal Velocity of Propagation (NVP) for 4-pair Horizontal Copper Cable.

1.9 QUALITY ASSURANCE

A. Refer to Section 27 0000 - General Communications Requirements which identify general quality assurance requirements for the Project.

1.10 GUARANTEE

A. Refer to Division 01, General Conditions, and General Requirements - Guarantee Documents for general warranty requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL

A. Cables and Termination hardware shall be technically compliant with and installed in accordance with referenced TIA documents.

B. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of Chicago Electrical Code and shall meet specifications of NEMA (low loss), UL 444, and ICEA (where applicable).

C. Horizontal (Station) Cable and Termination Components (Jack, Patch Panel) are specified to function as System.

1. Where required for warranty purposes, manufacturers of cabling and termination components used (if more than one) shall recognize each other in their Certification Programs.

D. 4-Pair Horizontal Copper Cables and Modular Jacks are application independent (e.g. no distinction between "voice" and "data").

2.2 4-PAIR HORIZONTAL COPPER CABLE

A. Manufacturers:
1. Acceptable Category 6 systems shall be:

a. Belden REVConnect 2400
b. CommScope SYSTIMAX GigaSPEED XL
c. Hubbell Premise Wiring NEXTSPEED 6
d. Leviton CX6200 Cat 6 Premium UTP System
e. Or approved equal

B. Cables shall be suitable for installation in environment defined

C. Cabling shall be packaged to minimize tangling and kinking of cable during installation.

D. Configuration:

1. Number of Pairs: 4 twisted pair

a. Pair twists of any pair shall not be same as any other pair.
b. Pair twist lengths shall be selected by manufacturer to ensure compliance with crosstalk requirements of TIA 568.

2. Conductors: insulated solid annealed copper pairs

a. Category 6: 23 AWG

b. Pairs of 4-pair cables shall be identified by banded color code in which conductor insulation is marked with dominant color and banded with contrasting color.

1) By pair number, pair colors or dominant band are:
   a) Pair 1: Tip - White/Blue; Ring - Blue (or Blue/White)
   b) Pair 2: Tip - White/Orange; Ring - Orange (or Orange/White)
   c) Pair 3: Tip - White/Green; Ring - Green (or Green/White)
   d) Pair 4: Tip - White/Brown; Ring - Brown (or Brown/White)

3. Cable Rating: CEC Article 800 Type CMR, UL listed
4. Maximum outside diameter:

a. Category 6: 0.258 inches

E. Horizontal Voice and Data Cable:
1. Shall meet or exceed TIA Category 6 performance requirements.
2. Shall not incorporate an overall shield.
3. Jacket Color:

a. Data: Light Gray (for Owner LAN and WLAN outlets)
b. Voice: White (for residential unit voice outlets)

## 2.3 HORIZONTAL COAXIAL CABLE

A. Manufacturers: CommScope, Belden, or approved equal.

B. Cables shall be suitable for installation in environment defined and shall meet Riser - CATVR rating (or permitted substitute as defined by CEC).

C. Station Coaxial Cable shall be RG-6 type, Quad-shield

D. Coaxial cable shall be sweep tested 5 MHz to 2.25 GHz.

E. RG-6 Type (Quad-shield)

1. Center Conductor: 18 AWG copper-clad steel.
2. Dielectric: foam FEP or equivalent as required for cable rating.
3. First shield: Aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
4. Second shield: 34 AWG aluminum braid wire (60% coverage).
5. Third shield: Non-bonded foil shield.
6. Fourth shield: 34 AWG aluminum braid wire (60% coverage).
7. Impedance: 75 ± 3 ohms
8. Velocity of Propagation: 83% nominal
9. Maximum Attenuation @ 68°F:

a. 55 MHz: 1.60 dB/100 ft
b. 750 MHz: 5.65 dB/100 ft
c. 1 GHz: 6.1 dB/100 ft

2.4 TELECOMMUNICATIONS OUTLET

A. Manufacturers: Refer to Acceptable Manufacturers list in section 2.2.A above “4-PAIR HORIZONTAL COPPER CABLE”.

1. All telecommunication outlets shall comply with the requirement listed in section 2.1.C above

B. Connectors (modular jacks and coaxial connectors (as applicable)) shall snap onto faceplate.

1. In surface-mount designs (if applicable) Jacks and connectors may mount to frame onto which coverplate is mounted.

C. Work Area Faceplate

1. Wall-mounted faceplates intended to be used in general work areas shall:

a. Be configured to mount on standard, single gang opening when wall mounted.
b. Accommodate minimum of 2 modular jacks and connectors.
1) Provide blank insert for all unused connector openings.

c. Be constructed of high impact plastic (except where otherwise noted).
d. Incorporate recessed designation strips at top and bottom of frame for identifying labels.
1) Triple row faceplates with no provisions for labeling of middle outlet row are not acceptable.
2) Designation strips shall be fitted with clear plastic covers.
3) Designation strips and covers shall be positioned over faceplate mounting screws.

2. Faceplate Color: to match electrical device faceplates.

D. Wall-mount Telephone Faceplate

1. Faceplates intended to be used in locations where wall mounted telephone set is required shall:

a. Be stainless steel construction.
b. Accommodate 1 modular jack meeting performance requirements for "Telecommunications Outlet" jack as defined above.
1) Modular jack shall be positioned to mate with wall-mounted telephone.

c. Mount on standard single gang opening.
d. Include mating lugs for mounting wall-mounted telephone.

E. Faceplate - Wireless Access Point Location

1. Faceplates supporting Wireless Access Point (AP) shall:

a. Accept 2 modular jacks or connectors.
1) Provide blank insert for all unused connector openings.

b. Be mounted in an enclosure designed for AP.
c. Be made of High Impact thermoplastic.
d. Incorporate recessed designation strips at top and bottom of frame for identifying labels.

2. Faceplate Color: to match electrical device faceplates.

F. Faceplate - Modular Furniture

1. Faceplates intended to be used on modular furniture shall:

a. Accept 3 modular jacks or connectors.
1) Provide blank insert for all unused connector openings.

b. Snap into modular furniture opening and be retained by integral latching tabs.
c. Match standard opening of furniture type(s) to be installed.
d. Have an optional extender bracket available to increase mounting depth as required to maintain cable bend radius within manufacturers' recommendations.
e. Be made of High Impact thermoplastic.
f. Incorporate recessed designation strips for identifying labels.
1) Modular furniture faceplate color shall match color of furniture panel.

2.5 MODULAR JACK

A. Manufacturers: Refer to "Telecommunications Outlet" above.

B. Modular Jacks shall be:

1. 8-position, 8-conductor (8P8C)
2. Non-keyed

C. Jacks shall have an attached color-coded wiring instruction label as an aid to installer.

D. Interface between jack and station cable shall be insulation displacement type contact.

E. Termination components shall maintain cable's pair twists as closely as possible to point of mechanical termination.

F. Jack contacts shall have minimum of 50 micro-inches of gold plating.

G. Data Jack shall:

1. Meet or exceed performance requirements of TIA Category 6.
2. Be color: Orange
3. Be utilized for all telecommunication outlets installed for the Owner LAN or WLAN.

H. Voice Jack shall

1. Meet or exceed performance requirements of TIA Category 6.
2. Be color: Shall match the color of the faceplate

2.6 COAXIAL CONNECTOR

A. Coaxial Connectors shall be threaded male F-type.

B. Male F-connectors shall:

1. Be matched to cable type used.
2. Be single piece connector.
3. Be Thomas & Betts Snap-n-Seal® or approved equal.

C. Use female/female feed-through couplings for coaxial outlets and patch panels (if applicable).

1. Coupling housing color shall match the faceplate color.

**PART 3 - EXECUTION**

3.1 GENERAL

A. Refer to project Drawings for outlet locations.

B. Provide Modular Jacks and Coaxial Connectors (if applicable) in faceplates as shown on Project Documents.

1. Provide [1] faceplate per Telecommunications Outlet symbol shown on Project Documents.

C. Maximum 4-pair Category-rated horizontal cable length shall not exceed 295 feet (90 m) measured from horizontal cross-connect (typically at TR) to Telecommunications Outlet.

1. Includes slack required for installation and termination.
2. Contractor is responsible for installing station cable to avoid unnecessarily long runs.
3. Any area that cannot be reached within above constraints shall be identified and reported to Engineer prior to installation.

D. Follow manufacturers recommended termination practices.

3.2 CABLE INSTALLATION AND TERMINATION

A. General

1. Refer to Section 27 0000 - General Communications Requirements for general cable installation requirements.
2. Provide "Service Loop" for every Horizontal Cable in ceiling above location where the conduit raceway feeding wall box location terminates.

    a. Loop length shall be 3.3 ft
    b. Total length of 4-pair Category-rated horizontal cable including loop shall not exceed 295 feet (90 m).
    c. Place loop in ceiling at last support (e.g. J-Hook) before cables enter fishable wall, conduit, surface raceway or box. Loop must be in accessible ceiling and not visible from below.
    d. Coil loop in figure 8 configuration.
    e. Loop radius (minimum) shall be 4X minimum bend radius for cable.

3. During installation, minimum bend radius shall be eight times outside diameter of UTP cables.
4. Route 10G UTP cable and other UTP cable categories independently. Do not bundle or share conduits. In cable tray segregate cable types using a physical barrier.

B. Horizontal Copper Twisted-Pair Cabling

1. Provide horizontal copper twisted pair cable between horizontal cross connect (typically at Telecommunications Room) and Telecommunications Outlet.
2. At Telecommunications Outlet, terminate each 4-pair Horizontal Cable on 8P8C Modular Jack.
   Terminating one cable on more than one jack is not allowed.
3. At horizontal cross-connect, terminate:

    a. Each 4-pair cable designated for Owner’s LAN or WLAN on 8P8C Modular Jack in Patch Panel.
        1) Owner cabling shall be application independent, no distinction between Voice and Data.

    b. Each 4-pair cable designated for Voice for residential units on Termination Block.

4. Terminate cables using 568B wiring standard.
5. Cable jacket shall be continuous to within 1/2" of termination.
6. Preserve pair twists to point of termination.
7. Refer to Section 27 0553- Communications System Identification section 3.4.E for labeling instructions.
8. Refer to Section 27 1100 - Communications Equipment Room Fittings for termination instructions for Modular Patch Panel and Termination Block.

C. Horizontal Coaxial Cable

1. Provide horizontal coaxial cable between Telecommunications Room(s) and coaxial workstation outlets.
2. At Telecommunications Room(s):

   a. Refer to Section 27 0553- Communications System Identification section 3.4.E for labeling instructions.
   b. Terminate cables in specified connector type.
      1) Prepare cables per manufacturers recommendations for connector type used.
      2) Ensure proper center conductor length as specified by manufacturer.
      3) Provide slack in each cable as required to reach any point in the designated splitter/tap connection area.
         a) Splitter/Taps shall be provided by others.

   c. Coil cables after termination for future connection by others.

3. Coordinate future splitter location with Owner to ensure adequate cable lengths.
4. At Coax Outlet, mate Male with Female port on Tap or Female/Female Feed-thru Coupling, whichever is applicable for the outlet type specified.

## 3.3 TELECOMMUNICATIONS OUTLET

A. Faceplates shall be configured to provide connectivity as required by location. Refer to drawings.

B. Mount modular jacks and connectors into faceplates and secure faceplates to outlet box, raceway or modular furniture.

1. Use faceplate extender if required to provide adequate clearance between jack and furniture to maintain minimum cable bend radius.
2. Provide blank(s) in unused jack/connector positions. Match color of blank to faceplate color.

C. Position Telecommunications Outlet for wall-mounted telephone in area clear of other utilities and wall mounted hardware.

1. Coordinate with other trades to maintain 8" clear space (minimum) on all sides from faceplate centerline.

3.4 FIELD TESTING

A. Refer to Sections 27 0000 - General Communications Requirements for guidelines regarding testing requirements common to all Division 27 Structured Cabling sections.

1. In addition, refer to sub-sections below for cable type under test.

B. 4-Pair Horizontal Copper Cable

1. Test from:
Horizontal Cross-connect (HC) to Jack at Telecommunications Outlet (TO).
2. Testing shall be per TIA-568 Permanent Link test configurations.
3. Maximum length of station cable shall not exceed 295 ft.
4. Cables shall be free of shorts within pairs, and be verified for Continuity, Pair Validity and Polarity, and Wire Map (Conductor Position on Modular Jack).

a. Identify and correct defective, split or mis-positioned pairs.

5. In addition to above, Performance Testing shall be performed on all cables. Testing of Transmission Performance shall include the following:

a. Length
b. Insertion Loss / Attenuation
c. Pair-to-pair NEXT
d. PSNEXT
e. Pair-to-pair ELFEXT (Equal Level Far End Cross-talk)
f. PSEFEXT
g. Return Loss
h. Propagation Delay
i. Delay Skew

6. Test cables to maximum frequency defined by standards covering specified performance category.
7. Perform Transmission Performance Testing using test instrument designed for testing to specified frequencies.

a. Test records shall verify "PASS" on each cable and display specified parameters - comparing test values with standards based "templates" integral to unit.

C. Horizontal Coax Cable
1. All cables shall be tested using Wire Test Instrument to:

a. Verify length
b. Verify Resistance
c. Verify impedance
d. Locate breaks/faults/incorrect terminations and large impedance changes

3.5 DOCUMENTATION

A. Refer to Sections 27 0000 - General Communications Requirements for documentation guidelines.

B. Information added by Contractor to Record Drawings relating to Horizontal Cabling shall include cable routes, outlet locations and numbering, and other detail necessary to document cable installation.

**END OF SECTION**

**SECTION 28 00 00**

**SECURITY MANAGEMENT SYSTEM (SMS)**

## PART 1 - GENERAL

1.1 SCOPE

A. General

1. This section details references, standards, guidelines, requirements and conditions common to Division 28 work.
2. Work under this Section and related sections is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 General Requirements.
3. Work to be done under this section of the Specifications shall include the furnishing of labor, material, equipment, and tools required for the complete installation of the work indicated on the Drawings or as specified herein. See drawings for location. (Drawings are to be utilized as a guide; actual equipment may vary).
4. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawings and Specifications, the Contractor shall bring. the discrepancies to the attention of the Owner for clarification and/or resolution.

B. Requirements

1. Employees

a. The Contractor shall furnish to the Owner a list of all key personnel and project representative(s) that shall be involved with the project.

2. Schedule
3. The Contractor shall prepare and maintain a detailed schedule that shall indicate activities for the life of the project.

a. Change orders
1) Any change orders must be approved by Owner prior to start of the change order work.

4. Finished areas

a. The Contractor may encounter parts of the Project, which include but are not limited to: wall/floor, landscaping, concrete, paint, trim, lighting and building mechanical/telecommunication systems.

b. The Contractor shall perform the specified work in such a manner that all finished spaces/areas are restored to the original condition, prior to the commencement of the Work.
c. During the course of performing the work specified herein, if the Contractor should encounter any damaged finishes in any area where the Contractor's work is to be performed, the Contractor shall notify the Owner in writing prior to performing work in that area. Only after receiving written confirmation that the existing conditions have been documented and that authorization has been given to proceed, shall the Contractor proceed with the work in these areas.

5. Painting

a. In some instances, pantone colors shall need to be matched to the surface being mounted to or coordinated with the architectural finish/wayfinding program. The Contractor shall coordinate the exact pantone color required for these surfaces with the Owner, prior to the provision of SMS equipment.
b. All conduit shall be run concealed.

6. Cutting, Drilling, Patching, etc.

a. The Contractor shall be responsible for providing any additional cutting, drilling, fitting or patching required, that is not indicated as provided by the Contractor to complete the Work or to make all parts fit together properly. The Contractor shall take care to:
   1) Submit a Cutting/Drilling/Patching request to the Owner in writing in advance of any alteration that affects:
   a) Other materials/labor that is not associated to the Contractor's work.

b. Structural integrity.
   1) Weather-exposed or moisture-resistant elements or barriers.

c. The Cutting/Drilling/Patching Request shall include:
d. Identification of area
e. Location.
f. Rationale/need for cutting or alteration.
g. Complete description of proposed work, approach and products to be used.
h. Effect on work of Owner or separate labor, material or other work.
i. Date and time work will be executed.
j. The cutting/drilling/patching materials shall be required to match original installation.

C. Submittals

1. Contractor shall provide five record drawings in accordance with requirements identified herein.

1.2 DEFINITIONS

A. General

1. Where required, terms are defined herein, which make up the provision of a Security Management System.

a. Except as otherwise defined in greater detail, terms "provide", "furnish", "install" and" assist" as used in Division 28 contract documents shall have the following meanings:
   1) "Provide" or "provided" shall mean "furnish, install, configure, test, adjust, and make completely ready for operation".
   2) "Furnish" or "furnished" does not include installation, configuration, testing, or adjusting.
   3) "Install" or "installed" shall mean "install, configure, test, adjust, and
   4) make completely ready for operation" but does not include furnishing.
   5) "Interface"shall mean the provision of cable/connector/hardware/direct/indirect labor/programming to facilitate functional/complete operation of equipment being directly or indirectly provided by the Contractor. Examples include, but are not limited to: software/hardware interfaces between two systems (e.g. fire alarm, elevator, door hardware, surveillance)
   6) "Assist": Aid in training, education and labor to develop interfaces, train or otherwise instruct the Owner on how to operate a specific piece of security equipment, develop a specialty application or work in consort with to perform a specific task

b. "AES": Advanced Encryption Standard
c. "Architect": RATIO Architects, Inc.
d. "API" – Application Programming Interface
e. "AHJ" -Authority Having Jurisdiction
f. "BMS" -Building Management System
g. "Consultant": Affiliated Engineering, Inc.
h. "Computer Network": A TCP/IP/ethernet connection that is not wireless
   1) "LAN": Local Area Network
   2) "WAN": Wide area network
   3) "GAN" Global Area Network

i. "Contractor" - General Contractor/Security Contractor
j. "Credential: Data assigned to an individual and used to identify that individual.
k. "Construction Documents" - Drawings, Specification, Owner and Division 1 Requirements

l. "Security/Telecom Room": an environmentally controlled centralized space for security equipment that usually houses head end equipment, servers, control panels, power supplies, and system cabling terminations.
m. "FXO": Foreign Exchange Office
n. "GUI"- Graphical User Interface
o. "Host/Server/Head-end": Computer configured as an access control system database/file server.
p. Labor:
    1) Direct: Labor provided by the Contractor
    2) Indirect: Labor provided by another trade/subcontractor to the Contractor

q. "PBX": Private Branch Exchange (Telephone Switch)
r. "MP": Mega-Pixel
s. "NIC" – Not-In Contract: Terminology refers to the anticipation that the Contractor shall subcontract portions of the work to a low voltage supplier/integrator. The intent of this definition is to communicate the work that is required by the low voltage supplier/integrators and is not intended to limit the scope of work for the contractor who shall provide all peripherals/labor/consumables, direct/indirect labor to fulfill the contract documents.
    1) "Trade" The Contractor shall provide all labor and equipment for SMS connectivity. In some instances, there will be other interconnectivity/third-party interfaces that shall be provided by other trades, which may or may not be subcontracted by the Contractor. The purpose is to delineate the work that is anticipated to be provided by the SMS trade.

t. "OS": Operating System (OS), software that is generally, but not exclusively manufactured by Microsoft Corporation or Red-Hat
u. "OSDP": Open Supervised Device Protocol
v. "Owner": PIRHL and CHA - Chicago Housing Authority
w. "Peripheral": Any equipment/component of the SMS but may not be identified on the plan drawings or specifications.
x. "Project": North Sheffield Development
y. "Programming": Developing, implementing various sets of instructions to enable the SMS to complete certain/specific operational tasks. This will include, but is not limited to: Migrations, conversions, IP configuration, security settings, device naming, access levels, groups, exceptions, card enrolment, CHUID definition, report development, SQL server programming, If/then/macros for soft/hard inputs and any other element for functionality of the SMS.
z. "RCP": Reflected Ceiling Plan
aa. "RF": Radio frequency.
bb. Secure Side of the door: Generally, on the opposite side of the access control reader/peripheral location.
cc. Specification - This document
dd. "SMS": Security Management System

1) "VMS": Video Management System
   a) "NVR": Network Video Recorder

2) "ACMS": Access Control and Alarm Monitoring System
3) "ACP": ACMS controller containing a database of cardholders and system operation parameters that allow it to operate independently from the system host/server when the communications between the server and ACP is not available.
a) "RM": Remote modules. Controllers that are located near anaccess control door and not at the ACP.

4) "VCS": Voice Communication Systems
a) "I"- General Intercom

ee. "TCP/IP or IP": Transport control protocol/Internet protocol
ff. "UPS": Uninterruptible power supply.
gg. "USB": Universal serial bus
hh. Security Products/Products – Shall mean items identified in the specifications, specifically those listed under Part 2 Products.
ii. "SIP": Session Initiation Protocol
jj. "VOIP": Voice Over Internet Protocol
kk. "Workstation": A computer with software that is configured for specific, limited security-system functions.
ll. Warranty/Guarantee - promise or an assurance that attests to quality or durability of labor, product or service that task will be performed in specified manner.
mm. "Wiegand": Cable and signal protocol
nn. "WLAN": Wireless Local area network
oo. "Work": Labor, materials, peripherals and programming required for a fully functional security management system

## 1.3 ABBREVIATIONS AND ACRONYMS

A. The following abbreviations and acronyms shall apply to this document and its companion sections for clarification and direction.

1. AFF Above Finished Floor
2. AWG American WireGauge
3. cm Centimeters
4. ft Feet
5. Gb Gigabit Ethernet
6. Hz Frequency in Hertz (k = kilo, M = Mega, G = Giga)
7. ID Inside Diameter
8. in Inch
9. m Meters
10. mm Millimeters
11. Mbps Megabits per second

12. OD Outside Diameter
13. PVC Polyvinyl Chloride
14. RU Rack Unit
15. sq. ft. Square feet (area)

B. Refer to individual technical sections for additional terminology.

## 1.4 PROJECT DESCRIPTION

A. The security management system shall consist of the provision for expansion of an existing Network Video Recorders (NVR) system, Access Control and Alarm Monitoring (ACMS), provision of a Voice Communication System (VCS) and any third- party interfaces described within this specification.

B. Horizontal and vertical cabling shall be encapsulated within conduit in accordance with the Raceway section of this specification, electrical specifications and Owner requirements. The Contractor shall coordinate with the Owner, cable management, which shall include labeling and any other raceway requirements. Cabling shall be neatly dressed and strapped, where required, in accordance with this contract documents.

C. If a Bidder has recommendations which will improve the performance of a system or which will limit costs without reduction of performance, the Bidder is encouraged to submit these recommendations, along with his bid, in the form of proposed voluntary alternates. Costs for alternates shall be shown separately from and not commingled with, the costs of the system as specified. All recommendations that are of value to the Owner will be considered in the evaluation of bid proposals.

## 1.5 GENERAL REQUIREMENTS AND CONDITIONS

A. General

1. Intent of drawings and specifications is to obtain complete, turnkey systems that are furnished, installed, configured, tested, adjusted, and made completely ready for operation. Include applicable incidental hardware, details, options, modules, accessories, subassemblies, etc. not shown or specified, but necessary for proper installation and operation.

2. This specification and the accompanying drawings are performance-based and diagrammatic, and are intended to convey the scope of work, design intent, and general arrangement of devices, equipment, etc. They also define the minimum material quality, required features, operational requirements, and performance of the systems. These documents do not convey every granular specifics, configuration or programming detail. Information provided herein and on drawings is current of the date, but field conditions may have changes since submission. The Contractor is solely responsible for determining required devices, components, equipment, accessories, wiring, connections, terminations, configuration, and programming to provide a complete and operational turnkey system that provides the required performance.
3. Contractor shall be solely responsible for determination of quantities of material, devices, equipment, etc. based on the information provided in the contract documents. Where discrepancies arise, the Contractor shall ask for clarification.

    a. If work and/or material, devices, equipment, etc. is depicted on the drawings, required in the specifications, or necessary for proper operation, it shall be considered part of this contract. Contractor shall include in their bid costs associated with the work and/or material, devices, equipment, etc. depicted on the drawings, required in the specifications, and necessary for proper operation.

4. Work areas shall be kept clean and orderly.
5. Programming

    a. The Contractor shall enter all data needed to make the system operational. The Contractor shall identify and request from the Owner, any additional data needed to provide complete and operational SMS.
    b. The existing systems may be under an existing warranty. Any programming of existing systems must be sub-contracted, or the existing warranty period taken over by the Contractor. Subcontracted programming shall be provided to maintain warranty.

6. Coordination

    a. Coordinate layout and installation of security system equipment and components with other construction that penetrates roofs, risers, within masonry/concrete, ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
    b. Camera device placement is generally shown; the Contractor shall refer to the Architectural Reflect Ceiling Plan (RCP) for specific mounting requirements.
    c. Pantone
        1) In some cases, security peripherals/products colors shall need to be matched to the surface being mounted to. The Contractor shall coordinate the exact pantone color required for these surfaces with the Architect, prior to ordering any security products.

d. Trades
   1) Coordinate with applicable trades interdependencies such as, but not limited to: electrical power, telecommunications, civil, elevators, roofing, door hardware, Building Management Systems (BMS), architecture, HVAC and others as applicable.

7. Penetration and Repair

   a. Includes but, is limited to the following, which must be coordinated, and if applicable, provided by the Contractor. This includes, but is not limited to the penetrations and repair of the following:
      1) Fire wall.
      2) Masonry.
      3) Riser/Sleeve
      4) Roof
      5) Light pole(s)

8. Cable Splices

   a. Unless otherwise noted, cabling shall be continuous without splices. Required splices shall be approved by the Owner, prior to proceeding. Splices that are provided without the Owner's consent that be replaced at the Contractor's expense or a warranty may be negotiated that would be acceptable to the Owner.

9. System Modifications

   a. The Contractor shall not alter manufacturer products, software or firmware without the manufacturer's written approval. Damage to systems, as a result of firmware or software modifications made by the Contractor, shall be the Contractor's responsibility to correct in manner acceptable to the Owner.

10. Networks

    a. The Contractor shall provide or coordinate a completely functional and dedicated network for the purposes of interconnectivity with the SMS. This network shall include, but is not limited to TCP/IP connection, RS-485 BUS, Wiegand and other communication cabling to support interconnectivity between systems envisioned and interfaces required to satisfy the work being performed.

11. Licenses

    a. The Contractor shall investigate and provide, as part of their work, all licenses required to support the operation and connectivity required for this project.
       1) Unless superseded by the Owner, the SMS system selected shall require one-time licensing, per component/peripheral, inclusive of multi-sensor cameras.

b. SMS/NVR/Camera devices that require annuity licensing/costs shall not be acceptable and annuity costs incurred for equipment provided by the Contractor shall be the burden of the Contractor when installed.
   1) Licensing shall include all aspects of the SMS, inclusive of third-party licensing as required for computer operating systems.

c. Software
   1) Although an integrated system is envisioned, the Contractor shall not co- locate multiple SMS licenses and SMS software applications on a single computer. Each SMS head-end/workstation shall be specific to each SMS component.

## 1.6 RELATED WORK

A. Related sections in other Divisions of Work:

1. Elevators
2. Section 08 7100 -Door Hardware
3. Section 260519 - Low-Voltage Electrical Power Conductors and Cables
4. Section 260526 - Grounding and Bonding for Electrical Systems
5. Section 260529 - Hangers and Supports for Communication Systems
6. Section 260533 - Raceway and Boxes for Electrical Systems
7. Section 260553 - Electrical Systems Identification
8. Section 260593 - Electrical Systems Firestopping
9. Section 270553 - Communications Systems Identification
10. Section 271500 - Communications Horizontal Cabling

## 1.7 REQUIREMENTS/REQUIREMENTS OF REGULATORY AGENCIES

A. Rules and regulations of Federal, State, and local authorities and of utility companies serving the project site in force at time of execution of contract shall become part of this specification.

B. Contractor shall perform work in accordance with applicable codes, laws, ordinances, and other regulations of the jurisdiction in which the project site is located and, where applicable, in accordance with published standards of the Owner that apply to the work performed.

C. Contractor shall perform work in accordance with applicable referenced standards, guidelines, and industry best practices.

D. Contractor shall perform work in accordance with applicable manufacturer's instructions, guidelines, and recommendations.

E. Where a discrepancy exists between applicable codes, laws, ordinances, regulations,

F. guidelines, industry best practices, Owner's published standards, manufacturer's

G. instructions, manufacturer's guidelines, manufacturer's recommendations, and contract documents, the most stringent direction that complies with applicable codes and regulations shall govern execution of work.

H. Changes to the work specified by the contract documents made after the letting of the contract made to comply with applicable codes, laws, ordinances, regulations, Owner's published standards, or contract documents or to comply with the requirements of the Authority Having Jurisdiction shall be made by the Contractor without any cost to the Owner.

I. Contractor shall include in their bid, costs associated with procuring permits, licenses, approvals, etc. applicable to work performed, including, but not limited to:

1. Costs associated with preparing documents for applications, submittals, etc. for review by an Authority Having Jurisdiction
2. Application, submittal, etc. charges, fees, taxes, etc.

J. Contractor shall include in their bid costs associated with required inspections applicable to work performed related to any permit, license, approval, etc. or any applicable codes, laws, ordinances, regulations, or Owner's published standards.

## 1.8 REFERENCES AND STANDARDS

A. The following design, cable, component selection, and installation practices reference and standards shall be applicable to the Contractor's work. In instances where there is a conflict with these standards/guides, the most stringent requirements shall be applied or rule unless superseded by local code, AHJ or Owner's written direction. References include:

1. Architectural Barriers Act (ABA)
2. American With Disabilities Act (ADA)
3. American Standards Association (ASA)
4. American Society of Mechanical Engineers (ASME)
5. Federal Communications Commission (FCC)
6. Federal Information Processing Standards (FIPS)
7. Homeland Security Presidential Directive 12 (HSPD)
8. Insulated Cable Engineers Association (ICEA)
9. National Electrical Contractors Association (NECA)
10. National Institute of Standards and Technology (NIST)
11. Occupational Safety and Health Administration (OSHA)
12. American National Standards Institute (ANSI)

a. ANSI/IEEE C2: National Electrical Safety Code
b. ANSI/TIA-5017: Telecommunications Physical Network Security Standard

c. ANSI/IEEE 1100: Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
d. ANSI/TIA/EIA 606: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
e. ANSI-J-STD-607-C: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

13. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

    a. ASHRAE: Operating temperature limits per Data Center Networking Equipment - Issues and Best Practices TC9.9
    b. ASHRAE: Thermal Guidelines for Data Processing Environments

14. American Society of Testing Material (ASTM)

    a. ASTM A 123: Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and forged Steel Shapes, Plates, Bars, and Strip.
    b. ASTM A 446: Specification for Zinc-Coated (Galvanized) by Hot-Dip Process, Structural (Physical) Quality.
    c. ASTM A 525: Specification for Steel Sheet, Zinc-Coated Galvanized by Hot Dip Process.
    d. ASTM A 607: Specification for Steel Sheet and Strip,Hot-rolled and Cold-Rolled, High Strength, Low Alloy Columbium or Vanadium.
    e. ASTM B 633: Specification for Electro-Deposited Coatings of Zinc on Iron and Steel.
    f. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials
    g. ASTM E-814: Standard Test Method for Fire Tests of Through-Penetration Firestops

15. Building Industry Consulting Service International (BICSI)
16. International Code Council (ICC)

    a. International Building Code
    b. International Fire Code

17. National Electrical Manufacturers Association (NEMA)

    a. NEMA VE 1: Metal Cable Tray Systems.
    b. NEMA: Section 250 Enclosures for Electrical Equipment.

18. National Fire Protection Association (NFPA)

    a. NFPA70: National Electrical Code.
    b. NFPA 101: Life Safety Code.

c. NFPA 731: Standard for the Installation of Electronic Premises Security Systems
d. NFPA 780: Standard for the Installation of Lightning Protection Systems
e. NFPA 5000: Building Construction Safety Code

19. Institute of Electrical & Electronics Consultants (IEEE)

a. IEEE 81: IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
b. IEEE 802.3af and 802.3at Power-over-Ethernet Standards.
c. IEEE 802.3an 10 Gigabit Standard
d. IEEE 837: IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
e. IEEE 1100: IEEE Recommended Practice for Powering and Grounding Electronic Equipment
f. IEEE/ANSI 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems

20. Telecommunications Distribution Methods Manual (TDMM)
21. Telecommunications Industry Association (TIA)

a. TIA 568-C.0 through C.3: Commercial Building Telecommunications Cabling Standard (including applicable Addenda)
b. TIA 569-B: Commercial Building Standard for Telecommunications Pathways and Spaces
c. TIA-862: Building Automation Systems Cabling Standard for Commercial Buildings
d. TIA/EIA-606-A: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

22. Underwriters Laboratories (UL)

a. UL 96: Lightning Protection Components
b. UL 96A: Installation Requirements for Lightning Protection Systems
c. UL 294: Standard for Access Control System Units
d. UL 294B: Standard for Power Over Ethernet (PoE) Power Sources for Access Control Systems and Equipment
e. UL 365: Standard for Police Station Connected Burglar Alarm Units and Systems
f. UL 467: Grounding and Bonding Equipment
g. UL 444: Communications Cables
h. UL 603: Standard for Power Supplies for Use with Burglar-Alarm Systems
i. UL 609: Standard for Local Burglar Alarm Units and Systems
j. UL 634: Standard for Connectors and Switches for Use with Burglar-Alarm Systems
k. UL 636: Standard for Holdup Alarm Units and Systems
l. UL 681: Standard for Installation and Classification of Burglar and Holdup Alarm Systems

m. UL 723: Surface Burning Characteristics of Building Materials
n. UL 827: Standard for Central-Station Alarm Services
o. UL 910: Tests for Flame Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air
p. UL 1076: Standard for Proprietary Burglar Alarm Units and Systems
q. UL 1479: Fire Tests of Through-Penetration Firestops
r. UL 1610: Standard for Central-Station Burglar-Alarm Units
s. UL 1635: Standard for Digital Alarm Communicator System Units
t. UL 1666: Tests for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
u. UL 2403: Fire Tests for Heat and Visible Smoke Release for Discrete Products and their Accessories in Air Handling Plenum
v. UL 2079: Tests for Fire Resistance of Building Joint Systems
w. UL Fire Resistance Directory Through Penetration Firestop Systems
x. UL 969: Marking and Labeling Systems.

23. Miscellaneous

a. Local city and county ordinances
b. Security Industry Association (SIA)
c. Open Network Video Interface Forum (ONVIF)

B. Physical Security Interoperability Alliance (PSIA)Applicable federal, state, local laws, regulations, and codes. Work performed under this section shall be completed in accordance with latest edition of referenced codes, standards, and specifications unless noted otherwise.

## 1.9 WORK/SYSTEMS BY OWNER

A. General

1. Owner shall provide:

a. Active TCP/IP/Ethernet network electronics (switches/routers) for interface with facility computer network and TCP/IP telephone system.
b. Active electronics for interface with facility digital telephone system.
c. Analog telephone lines and extensions and FXO ports.
d. Existing ACMS host server and software; excluding upgrade licenses and hardware related to the expansion.
e. Existing VMS server and software; excluding licenses and hardware related to the expansion.

## 1.10 DIRECT/INDIRECT INTERFACES

A. General

1. The Contractor, as part of their work shall provide any labor (direct/indirect), any consumables to interface directly or indirect equipment/hardware/software, which shall include, but not limited to:

    a. Dry contact
    b. Fire alarm
    c. Operators
    d. Door hardware
        1) Operators
        2) Request-to-exit interfaces
        3) Integration to specialized locking hardware or interlocks

    e. Alarms
    f. As applicable, integration to any SMS system identified herein
        1) VCS to ACMS or Phone system
        2) VMS/NVR to ACMS

## 1.11 EXTERIOR EQUIPMENT

A. General

1. All exterior devices shall be isolated/protected from surge/sneaker currents and shall either be fiber or equipped with control lined surge suppression devices:

    a. Fiber
        1) Preferably, any SMS component or device devices installed on the exterior of the building shall be connected to the SMS infrastructure via loose-tube (buffered) fiber optic cabling. For each fiber connection, a minimum of two (2) fibers shall be pulled from each device and home- run back to the security equipment room pursuant to the raceway requirements identified herein.
        a) Conduit, as required, shall be installed in accordance with the best practices of the trade including, but not limited to fill, innerduct, conduit and bend radiuses.

    b. Control line surge protection
        1) The Contractor shall supply surge suppression equipment in instances where fiber-optic cabling cannot be used because of limitations of the equipment being connected.
        2) Cables and conductors, except fiber optic cables, which serve as power, communication, control, or signal lines shall be protected against surges via triple electrode gas/rated solid-state surge protectors. Surge suppression shall be provided at each connection end and rated for the application on each wireline circuit and installed within three (3) feet of the building cable entrance.
        3) Enclosures

a) Exterior enclosures shall be rated for the environment they will be installed. Enclosures shall utilize security screws or integral key locking. When keys are used, enclosures shall be keyed the same. Contractor shall provide tool to Owner for servicing enclosures when security screws are used.

## 1.12 QUALITY ASSURANCE

A. General

1. Refer to the individual technical sections for general product quality requirements, manufacturer qualifications, contractor qualifications and certification requirements.
2. Peripherals and labor shall be produced by recognized commercial manufacturers/licensed, certified installers engaged in the production and installation of said equipment.

B. Products

1. Any alternate manufacturers, other than those identified herein shall have (5) years of documented experience in manufacturing, delivering, and supporting SMS equipment identified herein.
2. Materials shall be listed by and bear the label of a nationally recognized testing laboratory (UL, ETL, FM, etc.).

## 1.13 TESTING:

A. Pre-testing: All components and assemblies of the control unit are to be pre-tested at the factory prior to shipment.

B. On-Site Testing: Manufacturer trained, and authorized systems Integrator shall functionally test each component of the SMS after installation to verify proper operation and confirm that the panel wiring and addressing reflects field conditions and compliance with specifications.

## 1.14 CONTRACTOR

A. Contractor shall have a minimum of five (5) years documented experience in supplying, installing, and servicing the specified devices, components, equipment, materials and have specific experience with all peripherals and systems identified.

B. Contractor shall be qualified/licensed and where applicable certified on the systems being provided and offer and support applicable manufacturer warranties applicable to the specified systems, devices, components, equipment, and materials they propose for use on the project. Technicians shall be fully capable of providing instruction and routine and emergency maintenance service on all SMS peripherals.

1.15 SUBMITTALS

A. General

1. Submittals shall be prepared to include information required to demonstrate the Contractor's understanding and compliance with requirements of the Contract Documents. Unless superseded by Division 01; the following shall apply:

   a. Where a manufacturer has replaced a part number with a newer part number, provide the version of the product that is the manufacturer's most current offering available at the time of installation.

2. Product obsolescence/discontinuation
   1) Products/peripherals that will be obsolescent or no longer manufactured and or supported within six (6) months of installation shall not be permitted. The Contractor shall ensure that the newest products shall be provided. The Contractor at their expense shall replace any and all equipment that is slated for obsolescence/discontinuation within the timeframe allotted above.

   b. Where multiple manufacturers' names or manufacturers' part numbers are listed, the Contractor shall highlight or other distinguish which product/features shall be provided.
   c. Submittals should be transmitted as soon as practicable after execution of the contract. Submittals must be approved before materials are ordered, delivered to site, or installed.
   d. Refer to Division 01 for additional information and requirements.
   e. Refer to individual technical sections for additional information and requirements.

3. Incomplete submittals

a. Digital submittal documents that do not adhere to the requirements identified in this section shall be returned unreviewed as incomplete. The Consultant, at their discretion, may require the Contractor's subsequent/second submittal submission to be in a hard-copy format.
   1) As required by the Consultant, the subsequent submittal shall be via a three-ring binder, which shall be tabbed to the corresponding equipment, and comply with other requirements identified in this section. Costs associated to the preparation of a hard-copy submittal shall be burdened by the Contractor.
   2) Partial submittals shall be returned without review.

B. Contractor review

1. Contractor shall stamp the cover page of each shop drawing section submitted to certify that this internal review was completed, and necessary alterations were made to ensure compliance with requirements of the project documents prior to submitting the shop drawings for review.
2. Consultant review

   a. Shall confirm compliance with performance, interoperability, physical, and other pertinent requirements of project. Review is not to confirm quantities nor that all required items have been submitted by the Contractor.

C. Product Substitutions

1. Refer to Division 01 - Product Requirements for additional information and requirements.

   a. Unless noted otherwise, with Owner approval the Contractor may choose to use equivalent material from another manufacturer. Where Contractor chooses equivalent material from another manufacturer, Contractor assumes sole responsibility for ensuring that the alternate material is demonstrably equivalent to the listed basis of design, meets requirements specified in the project documents and that it fits in the allocated space. Contractor shall submit alternate material for approval, and Architect/Consultant shall make the final determination as to whether the proposed alternate material is equivalent and acceptable for use on the project.
   b. Contractor shall not substitute alternates for products, where substitutions/alternates are specifically prohibited.

D. Requirements

1. The Contractor shall provide a complete submittal, which shall include drawings, data sheets, and other information identified herein.
2. Provide area for Consultant's acceptance stamp.
3. Group submittals by section to include documentation of related systems, products and accessories.

a. Provide a table of contents for each submittal, to include each item being submitted. The table of contents shall include:
   1) All main SMS subsections shall be tabbed by corresponding sections/systems.

b. Nomenclature applied in the specifications and/or on the drawings to describe the SMS component (e.g., "Voice Communication System (VCS)")
c. Manufacturer and part number, where applicable
d. Reference to Specification Section or drawing where item is specified (e.g., "28 0000 - 1.9 - A - 4 - c - 1" or "Drawing SE-000")
   1) Product listing page

e. Identify manufacturer, model number, quantity of products to be used in the project.

4. Equipment specifications/data sheets shall be submitted as follows:

   a. Complete submittals should be transmitted as soon as practicable after execution of the contract. Complete submittals shall be approved before materials are ordered, delivered to site, or installed.

E. Narrative

1. To communicate the Contractor's understanding of the project, provide a written narrative that introduces the project, systems to be installed, connections and functionality.

F. Certifications

1. When required, identify and supply manufacturer's certifications/licensures for all SMS equipment/peripherals being installed.
2. Documentation that ownership of software and programming has been transferred to Owner.
3. Documentation of applicable product-related licenses, including documentation that licenses have been transferred to Owner.

G. Shop submittal

1. Product data

   a. Original color data/specification sheets for all peripherals, cable, connectors, and other SMS equipment shall be provided for the products that are intended to be installed. Identify products/equipment, including location and mounting requirements.

1) Product data shall also include miscellaneous consumables, which shall include: wire/patch cords, cable; terminal block connector's, etc.
2) Where required, annotated color specifics for products, inclusive of peripherals and miscellaneous consumables.
3) Where manufacturer's product data sheets include multiple part numbers, mark highlight or otherwise clearly identify products the sheets to indicate specific items being submitted.
a) Markings shall be reproducible (arrow, boxed, encircled, checkmark, etc.).
b) Product data that is not highlighted shall bind the Contractor to provide all functionality and equipment submitted.
4) Include a table of contents and mark manufacturer's product data sheets with nomenclature applied in the specifications and/or on the drawings to describe the item (e.g., "Credential Reader Cable").
5) When manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item and explanation for the discrepancy.
6) Where applicable, dimensions shall be marked in units to match those specified.
7) Provide manufacturer's product data for each item, component, device, and material proposed for the system. At a minimum, the data submitted shall clearly demonstrate compliance with each requirement specified in the Contract Documents.
8) Specific mounting details identifying, where applicable, hardware, brackets and reinforcement.
a) Brackets, mounting equipment, dimensions, filler plates, etc.

b. Provide SMS system power ratings and submit a report of their calculations. The report should identify the:
1) Voltage drop, electrical load calculations, etc. as it relates to devices being connected to electrical systems.
2) Provide battery calculations.
3) Submittals shall be prepared and submitted in electronic form and/or in printed hard copy form per Division 01.

c. Testing Sheet
1) Prepare verification test process and procedure, inclusive of a testing sheet for approval by the Owner.

2. Drawings

a. The Contractor shall prepare their own documentation and shall not utilize the Contract Documents at the basis of their design. In the event the Contractor utilizes/copies the Contract Documents as their design documents, the Contractor shall assume the liability/injunctive relief associated to any copyright violations that the Consultant may directly or indirectly hold.

1) The Contractor shall additionally indemnify and hold harmless Owner/Owner's, Consultant, Design Team Representative, its directors, officers, agents, employees, etc. against liability for any suits, actions, claims, losses, injuries, damages, awards, judgments and expenses of any character arising from or relating to the performance of the Contractor under this Contract, or actions by the Contractor during the preparation of submittals or during the execution of the contract documents.

b. Provide a CAD/REVIT generated project-specific system block diagram that clearly depicts system components and wiring, including proposed size of each conductor, and clearly illustrates the location of major system components, system topology, and interconnections between system components.

c. Drawings shall contain complete wiring and schematic diagrams and other details required to demonstrate conformance with the specification. Provide legends communicating symbols for all devices with block diagrams, mounting details, conduit, cabling type, size and gauge.
   1) Provide mounting details, indicating mounting, protective housings etc.
   2) Detail connections for 110v and low voltage power sources
   3) As required, provide console/rack installation, block diagrams, space allocation and cabling plans
   4) Provide wiring diagrams/risers and point-wiring schematics to panels, indicating utilized inputs and spare inputs.

d. Create labeling scheme, to include:
   1) Logic of alphanumeric identifiers for each component type
   2) Samples of each proposed label type (e.g., cable wrap, faceplate, patch panel, etc.)
      a) Samples shall be actual labeling products typical of those proposed for use on the project, including proposed font type, size, and print quality.
      b) Affix each submitted proposed label type to a sheet of backing paper.

e. Details of connections to power sources, including power supplies.
   1) As applicable, console/rack installation, block diagrams, and wiring diagrams shall be provided.
   2) Denote main cable pathways or individual home runs and where applicable voltage drop/signal degradation calculations.
   3) Detailed, labeled drawings, which denote device/peripheral connection inclusive of interconnections from device to final termination point.
   4) Provide equipment quantities and model numbers for all equipment being proposed.
   5) Define the drawings' scale in both standard and metric measurements.

6) Provide device identification and location.

H. As-Built Submittal

1. Data Sheets

a. Provide updated data sheets.

2. Drawings

a. Provide updated shop drawings, denoting all addendums and bulletins to the project.
   1) Identify all power schedules and switched panels that has been dedicated for security use.
   2) Correlate all labeling with wire and cable, which shall include the location, identification, panel, terminal connection and other information as required to communicate all cabling interconnectivity and landing/termination points.
   a) Mechanical splices shall be clearly annotated, if used.
   3) Legend and symbols shall be provided that clearly identify manufacturer's model numbers.
   4) Functional block diagrams for all subsystems, custom interfaces to work not part of the Contractor's scope.
   5) Elevations for equipment and risers, equipment rooms that shows installation of related equipment, interface panels, power supplies, junction boxes, and equipment cabinetry.
   a) Provide rack detail, which show equipment populations and their corresponding locations

3. Record drawings

a. Refer to Division 01 for additional information and requirements.
b. Refer to individual technical sections for additional information and requirements.
c. Drawings shall build upon the requirements identified in the shop submittal section.
   1) Provide final CAD/REVIT generated project-specific system block diagram, incorporating any deviations from approved system block diagram submittal and reference to project documentation that initiated the deviation. Diagram shall include unique alphanumeric identifiers for each item as so labeled.
   2) Provide CAD/REVIT-generated record drawings clearly documenting actual final locations of major system cabling routes and of system devices, system equipment, system topology, and interconnections between system components, and unique alphanumeric identifiers for each item as so labeled.
   3) Coordinate with Architect for designated set of contract documents to be used as a basis for record drawings.

4) A schedule for all of the SMS peripherals shall be included. All schedules shall provide the following information:
a) Device ID.
a) Device Location (e.g. site, building, floor, room number, location, and description).
b) Mounting type (e.g. flush, wall, surface, etc.).
c) Power supply or circuit breaker and power panel number.

4. Manuals

a. Manuals for all SMS components shall be organized in the same manner as shop submittals as specified above and shall have tabs for each system, sub-system, and piece of equipment.
b. Table of contents shall be identified on the cover and via a table of contents and tabbed to main heading for the table of contents. At a minimum the following shall be provided:
1) The manual shall include names, addresses, and telephone numbers of each trade installing equipment and systems, and nearest service representatives for each item of equipment for each system.
2) Installed products:
a) Provide original color product datasheets, describing the specification and technical requirements of each system component/peripheral or head-end system. Clearly identify model numbers, manufacturer names and miscellaneous engineering data. The Contractor shall highlight or otherwise clearly identify products to be used when submitted information lists multiple products numbers/systems/performance characteristics.

5. Quantities/model /numbers:

a. Provide a detailed overall listing of equipment quantities and equipment make/model numbers.

6. Operation manuals:

a. Refer to Division 01 for additional information and requirements.
b. Identify commands, recovery, restart, shutdown processes and general troubleshooting.
c. At a minimum, manuals shall include the following:
1) Copies of approved submittals, including review and approval forms.
2) Final manufacturer's product data for each item, component, device, and material that constitutes the installed system, incorporating any deviations from approved manufacturer's product data submittal and reference to project documentation that initiated the deviation.

d. Hardware/installation manuals:
1) Provide all manufacturer instructions and installation manuals for all Installed equipment.

a) When multiple like devices are being installed, a single manual shall be provided. The Contractor shall not submit identical manuals.
2) Manufacturer's owner's manuals and operating and maintenance
3) instructions:
a) Include parts lists of items or equipment. Where manufacturer's data includes several types or models, applicable type or model shall be designated.
4) Contact information for manufacturers, local suppliers/distributors, and service companies:
a) Name of primary contact
a) Street address
b) Mailing address
c) Voice phone number
d) Fax phone number
e) Internet/web page address

7. Programming/system manuals

a. Passwords
1) Password specifics for all systems, inclusive of manufacturer passwords shall be provided.
2) Passwords composition: Passwords shall be separate for all systems and shall utilize alpha numeric characters. Common passwords for multiple peripherals shall not be acceptable.

8. Network/TCP/IP matrix

a. The Contractor shall create and maintain a network matrix, which shall identify the following for all security peripherals that connects to a dedicated/shared computer network:
1) Device name
2) Manufacturer name
3) Model number
4) Software version as applicable,
5) Internet address and logical ports
6) MAC address
7) Patch-port connection
8) Network Switch port connection
9) VPN/Subnet
10) Identify edge storage and capacities

9. Bandwidth/Resolution/storage/frame rate calculations
1) The Contractor shall provide detailed calculations, storage capacities and bandwidth allocations for all surveillance equipment connected to a computer network. Specifically, this shall include:

a) Camera number, location, type, resolution, frame rate, number and individual resolution streams (frame rate/resolution), bandwidth for total streams and anticipated storage requirements for a thirty-day period.
a) Recording for each camera to include compression, frame rate, sequential or conditional refresh, record resolutions, record retention and storage needs and type of storage (mirrored/RAID, SAN, etc.)

I. Maintenance Manuals

1. Maintenance manuals shall contain all information required for maintenance, inclusive of inspections, preventative maintenance, logical maintenance (defragment, etc.), diagnostics, and replacement/repair of defective components.

a. Manuals/videos:
1) Any material used to train the Owner, inclusive of printed, digital or audio-visual material shall be provided.

2. Operation and maintenance manuals and record documents

a. Test results
b. Applicable warranties
c. Identification of and contact information for manufacturer and supplier/distributor product support.

3. Product samples

a. At the request of the Owner, provide product samples for proposed equipment.

4. Submittal delivery

a. Upon completion of work but before final acceptance of system, submit to Architect for approval, one (1) printed copy of operation and maintenance manuals in loose-leaf binders and one (1) electronic copy of operation and maintenance manuals in pdf format.
1) After securing approval, submit three (3) printed copies and one (1) electronic copy to Owner.
a) Electronic copies shall be in .PDF, CAD and where applicable Revit models shall be provided.

b. Contractor acknowledges that all materials shall become the property of the Owner.

J. Submittal rejection

1. Incomplete or partial submittals

a. Partial submittals shall not be reviewed and returned to the Contractor for finalization.
b. Submittal documents that do not adhere to the requirements identified in this section shall be returned as incomplete. The Consultant, at their discretion, may require the Contractor's subsequent/second submittal submission to be in a hard-copy format.
    1) As required, costs associated to the preparation of a hard-copy submittal shall be burdened by the Contractor.
c. Submittals that are illegible, not complete, not properly checked by the Contractor shall be returned without review.

K. Submittal Allowance

1. The Consultant shall review two (2) submittals. Additional costs (labor and expense) incurred by the Consultant for subsequent reviews beyond this allowance shall be burdened by and paid by the Contractor.
2. Testing

    a. The Contractor shall provide a report detailing the results of the field test as and shall be delivered after completion of the tests.

1.16 WARRANTY

A. General

1. Refer to Division 01 for general Warranty/Guarantee requirements. Unless specified otherwise in Division 01 or in an individual technical section.
2. The warranty period shall be for a minimum of one (1) year and shall begin immediately after the Owner's written acceptance for the systems beinginstalled.
3. When manufacturer offers a standard warranty that extends beyond one year, the published duration of the manufacturer warranty shall govern and be extended to the Owner.
4. The guarantee shall warrant work performed and materials, devices, equipment, etc. provided to be free from any defect or malfunction.
5. Contractor shall, at Owner's sole option, repair, replace, or correct materials and/or workmanship found defective or found to otherwise not conform to the contract documents, at no extra cost to Owner. Contractor shall also bear costs associated with correcting any damage resulting from defective or nonconforming materials and/or workmanship.
6. Include all labor (direct/indirect), any consumable/material, which shall include shipping costs and travel time.

B. Warranty service and preventative maintenance

1. Preventative maintenance and service shall be provided by the Contractor for a period identified in the warranty section. The Contractor shall provide labor and consumables as required to maintain and service the SMS during this period.

    a. A 24/7 call center or emergency point of contact shall be provided to the Owner during the warranty period, excluding federal holidays.
        1) Service calls – System inoperability
        a) Upon initiation of a service call by the Owner, the contractor shall dispatch direct/indirect personnel who are trained on the respective system to provide corrective repair.
        a) Service personnel shall be at the site within four (4) hours after receiving the service request.
        b) The SMS shall be restored to proper operating condition within a maximum of two (2) calendar days subsequent to the initial request.

2. Service personnel

    a. The Owner shall be advised in writing of the name of the designated service representative, and of any change in personnel.

3. Preventative maintenance

    a. Preventative maintenance/scheduled adjustment shall be providing over the course of the Warranty period and in accordance with manufacturer recommendations and are intended to test the operations of the system. The Contractor shall perform a minimum of three (3) inspections, which will not be less than every three (3) month, but more as required by manufacturer best practices:
        1) Preventative maintenance shall be done in accordance with manufacturer recommended practices. Outside of manufacturer requirements, the following shall be conducted:
        a) Visual checks, and operational tests of SMS equipment and peripherals
        a) Mechanical adjustments
        b) Interviews with SMS operators to proactively identify concerns
        c) Cleaning of surveillance cameras
        d) Software/firmware updates: Applying all related software patches, updates – with permission of Owner
        e) Defragmenting systems and other hardware maintenance

    b. The Contractor shall recommend all software updates to the Owner for approval. Upon Owner approval, updates shall be accomplished in a timely manner, fully coordinated with the security system operators, operation in the
    c. system verified and shall be incorporated into the operations and maintenance manuals, and software documentation.

1) The Contractor shall make recommendations for system modification in writing to the Owner. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Owner.
2) Any Owner approved modifications made to the systems shall be incorporated into the operations and maintenance manuals and other documentation affected.
3) There shall be at least one scheduled manufacturer software update near the end of the first year's warranty period, at which time the Contractor shall validate and as required update the firmware/software to the most recent non-beta release.

4. Documentation and Records

a. Warranty records
1) The Contractor shall keep records and logs of each task and shall organize cumulative records for each major component chronologically. A continuous log shall be maintained for all devices and shall contain service, calibration, repair, and programming data. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the security system.

b. Service
1) The Contractor shall separately record each service call request, as received on a form. The form shall identify:
a) Date and time the call was received
a) Nature of trouble Component involved
b) Location of component
c) Names of the service personnel assigned to the task
d) Time and date work started
e) Work completed
f) Time and date of completion

5. Existing warranty

a. As required, the contractor shall be required to maintain the existing Owner's warranty by subcontracting, where appropriate, installation (indirect programming) of the existing SMS head-end equipment.

**PART 2 - PRODUCTS**

2.1 GENERAL

A. Contractor shall provide new materials as indicated in the contract documents, unless specifically noted otherwise.

B. Where manufacturer has replaced a part number with a newer part number, provide the version of the material that is the manufacturer's most current offering available at the time of installation.

C. Where multiple manufacturers' names or manufacturers' names and part numbers are listed, the basis of design listed is to be considered the benchmark for quality, features, and functionality for that material.

D. Refer to individual technical sections for additional information and requirements.

E. Product Substitutions

1. Refer to Division 01 - Product Requirements for additional information and requirements.

a. Unless noted otherwise, Contractor may choose to use equivalent material from another manufacturer. Where Contractor chooses equivalent material from another manufacturer, Contractor assumes sole responsibility for ensuring that the alternate material is demonstrably equivalent to the listed basis of design, meets requirements specified in the project documents for that material, and fits in the allocated space. Contractor shall submit alternate material for approval, and Architect/Engineer shall make the final determination as to whether the proposed alternate material is equivalent and acceptable for use on the project.

## 2.2 ACCESS CONTROL AND ALARM MONITORING SYSTEM (ACMS)

A. The Contractor shall expand the existing system with the following features:

1. Graphical User Interface (GUI)

a. The Contractor shall provide a Graphical User Interface (GUI). The GUI interface shall be a via windows 64-bit operating system, current with all service packs and software patches and shall be seamlessly and graphically integrate ACMS, VMS and VCS into a single menu driven platform, which shall have graphical maps, and on-screen icons. System functions and sub-programs shall be selectable from a hierarchy of logically organized menu displays (may be pull down, pop-up type) or on-screen control icons. A specific function within a menu display shall be launched via shortcut key(s) entered at the workstation keyboard or by selecting a command control button on the dialogue box on screen with a mouse or other pointing device. Alternatively, double clicking on a selected icon with a mouse can launch specific system operations, such as camera call-up.

b. Upon a card/key fob read at designated locations, associated card credential/key fob holders' photo shall display on the security workstation(s) monitors. Contractor to coordinate locations with Owner.
   1) Capability to import a .DXF or .DWG file to produce a current site drawing overlay on the system. The Contractor shall furnish the latest drawing for incorporation into the system.
   2) The system shall support system icons that shall be a direct link to the door, camera or event (live, pre-alarm, alarm events). Alarms and access- controlled doors/cameras shall both be depicted by icons overlaid on the
   3) .DXF or .DWG site drawing.
   4) The GUI interface shall have the capability to interface to direct/indirectly provided equipment/systems, limited to but, notwithstanding VMS, VCS. systems, building monitoring systems, fire systems, elevator control systems etc.

2. The ACMS shall be manufactured by Genetec or Owner approved equivalent.

B. ACMS Interfaces

C. Fire Alarm Interface

1. Door hardware power supplies shall be capable of receiving a relay input from the fire alarm system, per prevailing code requirements. This relay input shall be solely utilized for deactivation (unlocking) of access-controlled doors within a path of egress upon initiating signal from the fire alarm system.

   a. Refer to Division 26 drawings for the location of fire panels and U.L./fire interface connection points.
      1) The Contractor shall be required cable and conduit for connection to fire interfaces for all doors within a path of egress.

D. Other device Interface(s) & Operational Criteria

1. The Contractor shall be responsible for providing interfaces as required to provide control, monitoring, and functionality of the following devices:

a. Request-to-Exit Devices
   1) The Contractor shall be required to interface to request-to-exit device equipment

b. Operator
   1) Roll-Up/Sliding Doors/Gate Operators
   a) The Contractor shall interface with roll-up door operators being provided. The control of these doors shall provide a direct interface with the ACMS card holder database, allowing authorized card holders to activate the roll-up doors through the use of a card
   a) reader or remote operation. The ACMS shall also have the capability of opening, holding, and closing the roll-up doors though on-screen icons/commands that are generated from the ACMS GUI.
   b) All safety features of the roll-up door operator shall be preserved and shall not interfere with the safety or operation of the roll-up door.
   2) Optical beam/Passive Infra-Red (PIR)
   a) Provide optical beam devices/reflectors as shown on details to facilitate select operation of doors equipped with extended range reader.
   3) Accessible Door Operators
   a) The Contractor shall provide an interface for controlling doors equipped with accessible door operators (handicapped door opening buttons), provided by Contractor. The following conditions must be met and shall be provided by the Contractor:
   a) Accessible door operators shall not be functional until the presentation of an approved access control card. The access control card shall enable the handicapped push pad, which shall energize the door operator.
   b) Following a pre-set time period, to be coordinated with the Contractor, the automatic door opening device shall shut close and the door shall re-lock.
   c) The Contractor shall provide any and all interfaces to allow exiting from doors equipped with door operators and electrified hardware controlled by the ACMS. The Contractor shall provide a connection to the handicapped operator or third-party request-to-exit sensor to de-energize/energize the associated hardware, prior to activation of the door operator.

2. Network Switching Equipment

   a. The Owner shall provide all network switching equipment. The Contractor shall provide connection from the camera to the biscuit box/keystone via a pre- certified patch-cables.

3. Rapid-Entry Boxes (Knox boxes)

   a. Provide tamper/dry-contact closures to all rapid-entry boxes. Rapid entry alarms shall be uniquely identified on the ACMS.

4. Alarm Panel (AP)

    a. Interface via software or dry-contact closure shall be provided from the ACMS to the AP for exterior doors.

5. Magnetic hold-open(s)

    a. The Contractor, at select doors, shall provide a relay to remotely de-energize magnetic hold-open devices to allow doors to close. Refer to drawings for locations.

6. Intercom

    a. Provide interface with the intercom, so that relays activated by the VCS system shunt the associated door position switch for the ACMS.

7. Video intercom

    a. Provide interface with video intercom, so that relays activated by the VCS system shunt the associated door position switch for the ACMS.

E. Access Control Panel (ACP)

    a. ACP communication shall be transmitted to the ACMS via a serial, dedicated or shared network connection from distributed location(s), which are identified on the security drawings.
        1) Encryption
        a) ACP shall utilize supervised OSDP-compatible RS-485 connections to access control peripherals, inclusive of user/biometric template transfer.
        a) Wiegand cabling shall not be used, unless connecting to existing equipment.

        2) Security drawings identify the proposed location for access control panels, however, do not identify the quantities or equipment specifics. The Contractor shall provide the necessary number of ACP's, which shall account for all connected peripherals plus support an additional 25% expansion for future peripherals. This includes all hardware, materials and software required to accommodate this expansion, but excludes future peripherals (access control readers) that would be connected to the ACP.

    b. ACP's shall hold the following characteristics
        1) ACP's shall include all components inclusive of power supplies, control circuitry to energize or de-energize power circuits to NIC electric door locking devices. They shall additionally hold memory/logic to support uninterrupted operation and independent decisions when the host server connection is lost.

a) Shall meet UL requirements.
b) Off-line events

2) The host server shall continuously poll ACP panels connected to it; frequency of polls shall be selectable by the Owner.
3) An alarm shall be generated to the ACMS server and associated client servers when ACP communication has been lost with the host or regional server.

c. Peripheral capacities
1) Each ACP shall support up to a minimum of eight (8) access control inputs, connected in any combination, inclusive of a remote module via a RS-485 BUS.
2) A minimum of sixteen (16) alarm devices via 2-wire, current supervised circuits and twelve (12) relay outputs shall also be provided, excluding those provided via a RS-485 BUS.
3) When disconnected from the host server, the ACP shall store in local memory the time, date and where applicable card holder data for:
a) Events/transactions
b) Alarms: Intrusion or any input facilitated by a dry contact or logical interface
c) Transactions: Access control authorization, rejection and where applicable floor tracking.

4) ACP transactions shall be buffered and uploaded to the ACMS once communication is restored.
5) Response
a) The ACP shall activate the relay not less than (1) one second after the presentation of a valid access control card or remote activation by a button or workstation.
b) Transactions/events/alarms generated by the ACP shall be communicated to the ACMS host server no less than (2) two seconds from the actual event.

d. Battery
1) ACP's shall incorporate provisions for uninterrupted standby battery power as required to insure continued operation in the event of power failure. ACP shall signal to the ACMS in the event of:
a) Main power loss
b) Low battery
c) Battery short/failure

2) Battery back-up shall be maintained in the event of a power loss for no less than four (4) hours.

e. Firmware

f. The ACP shall be a microprocessor-based device that uses flash firmware technology to enable upgrades/patches from the ACMS. The ACP shall conduct an internal error checksum on all uploaded firmware to a secondary bank of memory, prior to the update. The error checksum shall ensure that the firmware is free from corruption.
   1) Field replaceable socket firmware shall not be acceptable

g. Modifications
   1) The Contractor shall not under any circumstance alter or modify hardware, software or firmware without the manufacturer's written
   2) approval. Damage to systems as a result of any unauthorized modification shall be the Contractor's burden to correct.

h. Update
   1) The Contractor shall update the ACP firmware to the most current (non- beta) release, prior to the warranty anniversary. The firmware update shall be part of the Contractor's work and at no cost to the Owner.

i. Installed memory
   1) Installed memory shall support the following capacities in an off-line state when the ACP has lost connection to the host server/ ACMS.:
   2) Card holders: 1,000
   3) Events/Transactions: 3,000

j. The Contractor shall provide adequate memory within the ACP to satisfy the identified capacity requirements.

k. Other requirements
   1) The ACP shall be enclosed within a key lockable housing with a hinged door complete with a tamper switch.
   2) Cabinets shall be keyed alike, and a key shall be provided to the Owner.

l. Tamper
   1) The ACP shall provide cabinet tamper circuitry, such that access to the ACP circuitry, power supplies, and peripherals are continuously monitored. ACP tamper alarms, shorts, battery, and communications failures shall be uniquely identified in the ACMS database. Tamper/battery alarms shall cause unique annunciation at operator workstations when activated.

m. Electrical
   1) All power connections to the ACP shall be via conduit. All connections shall be hard-wired. Plug in transformers shall not be acceptable.
   2) ACP operating power shall be/via low voltage step down transformers and connected to emergency generator power circuits, if applicable.

3) Low voltage transformers shall be enclosed within ACP cabinets or a suitable auxiliary housing.

n. End-of-line resistor
1) The Contractor shall supply End-of Line resistors (EOL) at the device, and not within the ACP. EOL's shall be rated pursuant to ACP manufacturer requirements.

o. ACP Communication
1) The Contractor shall be responsible for the installation of all transceivers and miscellaneous communication devices as required for connection to the host server.
2) Host communication to/from the ACP panel shall be via Ethernet/TCP/IP.
3) Peer to peer and panel to panel communication
a) Where required, contractor shall provide licenses, hardware/connectivity to support panel to panel communication for features such as lock-down or similar.

p. Portals
1) Access control reader shall be configurable in multiple ways. It will be possible for the ACP to group multiple access control readers to a single door, multiple doors or their related inputs/outputs.

q. Global communication
1) The ACP shall be able to facilitate peer-to-peer or host-to-peer communication for initiating global responses, such as a lock-down, where multiple doors/interfaces shall need to change state throughout the project. (e.g. activation of lockdown button shall recall elevators and lock all doors).

r. ACP shall be fully compatible with the ACMS being supplied.

F. Access Control Reader

1. General

a. Access control readers shall be UL-294 multi-technology type access control readers, capable of communicating at 125KHz and 'smart' 13.56MHz frequencies as shown on security drawings.
1) In some instances, an integral numerical keypad shall be integrated into the access control reader. Refer to drawings for locations.

b. Presentation of a valid credential, and subsequent authorization by the ACP shall temporarily shunt or activate power to the electrified hardware and internally shunt the associated door monitoring switch or switches for a predetermined amount of time to be coordinated with Owner.

c. Access control readers shall be a sealed in a single package weatherproof unit and shall be constructed of high impact ABS plastic. The color of the card readers shall be coordinated with the Owner prior to ordering.
d. Access control readers shall be powered by the ACP; Contractor shall adhere to the manufacturer's guidelines for maximum distance from the reader to the security panel.
e. Accidental or intentional transmission/dampening of radio frequency signals at/into the reader shall not compromise the ACMS or ability to read the credential.
f. Tones
    1) Access control readers shall incorporate a dual means of notification of door operation. Specifically, the access control reader shall supply local audible tone/visual notification for access granted, access denied, out of service and door propped conditions. Each of these notifications shall be selectable by the host ACMS system.

g. Requirements
    1) Access control readers shall be initially configured to communicate at 125 kHz.
    2) Mullion mounted readers shall not be allowed unless otherwise indicated on the drawings.
    3) Reader shall communicate via standard Wiegand output/RS-485.
    4) Read range shall be not less than 2".

h. Access control readers shall be equipped with a tamper switch to indicate if the faceplate has been removed from the card reader.
i. Typical access control readers shall be provided on a double gang deep back- box with a single gang trim ring. The Contractor shall take care in mounting the access control reader and provide spacers, as required, to prevent radio interference. Standard card readers requiring a special back box shall not be acceptable.
j. Protection
    1) As shown on drawings, the contractor shall provide a Lexan/polycarbonate, nonferrous protector for select access control readers to prevent damage by fork-lifts, carts and similar.

2. Typical single-gang access control readers shall be manufactured by HID; substitutions shall not be permitted.

G. PROXIMITY ACCESS CONTROL CARDS

a. The Contractor shall provide proximity access control cards/key fobs to the Owner. Contractor to coordinate quantalities with Owner.
b. Access control cards/key fobs shall be a format compatible with the card readers/key fobs being provided and shall be utilized in conjunction with a security panel to associate the access level associated to the user of the card.
c. Proximity cards shall be compatible with the badge printer.

1) Proximity access control cards shall also allow either a horizontal or vertical punch slot. Coordinate the punch slot with the Owner.

d. Each access card/key fob shall be uniquely encoded by the card manufacturer and shall transmit a compatible format output to the card readers.
e. Proximity access control cards/key fobs shall be manufactured by HID Corporation or Owner approved equivalent.

2.3 VOLUMETRIC EXITING DEVICES (VED)

A. General

1. Volumetric Exiting Devices (VED) shall be provided as indicated on the security drawings or door hardware schedule and utilized to signal the authorized egress from a space. Upon activation, the ACP shall shunt the door position switches and energize or de-energize electrified hardware associated to the door allowing egress.
2. VED shall utilize dual technology for activation via Passive Infrared (PIR) and a supplementary, simultaneous volumetric detection type.
3. The output from the device will be a Form C SPDT relay designed for momentary action.
4. Surface mounted VED shall have an adjustable detection pattern that shall not extend more than 4" from the threshold of the door.
5. VED detectors shall be mounted on the door frames or the wall above the door via a double gang junction box and single gang trim ring.
6. VED devices shall only be utilized when integral request-to-exit micro switches cannot be utilized (e.g. glass doors, magnetic locking).

B. VED devices shall be Interlogix/Aritech or Owner approved equivalent.

2.4 EMERGENCY DOOR RELEASE BUTTON

A. General

1. Emergency door release button shall be furnished and installed as shown on the drawings and shall serve to interrupt/energize power locally at the locking hardware/operator associated to the door where the device is located.
2. Activation of the emergency door release button shall not shunt the associated door position switch and create an alarm at the ACMS.
3. The button shall mount to a double gang box with a single gang trim ring and shall be designed with a latching operation and shall be manually reset without tools, keys, etc.

a. Emergency door release button shall be provided large button at least 1” in diameter or 2” square and shall be silk screened/engraved with the letters “Emergency Push to Exit”

B. Emergency override pushbuttons shall be manufactured by Securitron, Locknetics or Owner approved equivalent.

C. Door Monitoring Switch(s)

1. General

a. Excluding roll-up doors, door monitoring switches shall be provided by the door hardware trade. The Contractor shall provide end-of-line resistors, and related cable for connection to the nearest ACP.

2. Roll-up door monitoring switches shall be U.L rated and shall be provided as indicated on the drawings and shall be recessed unless otherwise noted. Door monitoring switches shall indicate the position of the associated door, either open, closed, held, short or forced open and shall consist of a sealed assembly designed for either metal or wood frame installation.
3. The Contractor shall supply only magnetic types of door monitoring. Mechanical types of door monitoring shall only be acceptable when used as a tamper switch.
4. Surface mounted switches: shall be high-security and shall only be used for rolling, overhead or similar door types where recessed mounting is not practical/possible or additional security required.

a. Surface mounted door position switch(s) shall be supplied with armored cabling, properly supported to a junction box above 10', then run open cable back to the nearest ACP.

5. The Contractor shall supply necessary equipment for preventing a voltage surge to prevent damage to any panels or to the device itself.

D. Door positions switches shall be a single pole double throw (SPDT) type or multiple switches shall be integrated into the door monitoring switch.

E. End-of-line resistors

1. End-of-line resistor shall be required at the end of the device and shall not be located in the ACP.
2. Excluding tamper switches, each door monitoring switch shall be a logical point unless otherwise noted on the drawings. Grouping multiple doors in series as a single logical point shall not be permissible.
3. Door position switches shall be manufactured by Sentrol, Magnasphere, or approved equal

F. Local Alarm

1. General

a. Local alarms are hardwired devices that shall serve as an audible localized deterrent to a propped door or unauthorized exit through an emergency only door. Resetting of local alarms shall be accomplished locally either via an onboard or remote key switch.
   1) Local alarms shall be rated at 82 decibels (dB) from a distance of ten (10) feet and will signaled via a SPDT door monitoring switch from the door that the local alarm is associated to.
   2) Local alarm mounting shall either be:
   a) Flush ceiling/wall shall be used in all finished spaces
   b) In the event that field conditions require ceiling mounting, the Contractor shall provide a local and easily accessible (wall mounted) means to reset the local alarm via a key switch.

   3) Ceiling mounted units shall be equipped with a safety chain/cable affixed to the structure to prevent injury in the event that the unit falls
   4) Surface mounted shall be used in unfinished spaces.

b. A single key for bypass/resets of all local alarms shall be provided, individual reset keys shall not be acceptable.
   1) Local alarms shall be supervised and shall be equipped with tamper resistant screws as well as a tamper alarm. Multiple inputs to a common local alarm shall not be permitted, unless denoted otherwise.

2. Wiring

   a. Door monitoring shall be wired independently from the ACP and the local alarm device. In every instance one lead of wires shall annunciate an alarm at the ACP and a second lead shall simultaneously annunciate at the local annunciator device.
      1) Contractor shall provide wiring to support remote deactivation of the local alarm.

3. The local alarm shall be manufactured by Designed Security, Inc. Model ES-430-K2 Exit Alarm with key reset switch or Owner approved equivalent.

## 2.5 ELECTRIFIED HARDWARE POWER SUPPLIES

A. General

1. The Contractor shall provide power supplies and related cabling to door hardware. Power supplies shall be located within equipment rooms where the ACP shall be housed exact number of power supplies shall be based on field conditions.

B. Equipment Requirements

1. Power supplies shall be selected based on the locking hardware being supplied by the door hardware provided.
2. The contractor shall extend and connect low voltage cabling from the power supply to the associated locking hardware.
3. Unit shall be UL Listed Class II power limited power supply with 120-volt AC hardwired input. Output power shall be regulated, filtered individually fused 12-24-volt AC/DC and shall have output rating equivalent to 130 percent of the actual electrical load.
4. Power supply enclosures shall be lockable, keyed alike and equipped with a tamper switch that shall connected to the ACMS.
5. Power supplies shall be equipped with a minimum of a (4) four-hour backup battery for continued electrified lockset operation after a power failure and shall de-energize in accordance to egress, life-safety and prevailing code requirements.
6. Relays

    a. Power supplies shall be equipped with an offboard 24V power relay or manufacturer specified module that shall include communicate the following status to the ACMS:
        1) Power failure
        2) Low battery warning

7. Fire Relay

    a. Contractor shall provide a U.L listed really connection from the nearest fire alarm panel, which shall be utilized to de-energize/energize locking hardware that is within a path of egress only. Contractor to coordinate egress locations with Architect and door hardware supplier.

C. Electrified Hardware Power Supplies shall be manufactured by SDC, Altronix, Life Safety Power or Owner approved equal

## 2.6 VOICE COMMUNICATIONS SYSTEM (VCS)

A. General

1. The Voice Communication System (VCS) shall be microprocessor controlled and support duplex/simultaneous bi-directional voice communication. Components of the VCS are described herein and as shown on the plan drawings.
2. Initiating stations shall be vandal resistant, ADA-compliant, hands-free speakerphone communications device(s) with a stainless-steel faceplate and metal buttons furnished. VCS initiating stations shall be provided to meet the environment they are being placed in (i.e. outdoor stations shall be weatherized).

3. The VCS system shall communicate over a computer network and shall include required communication hubs/routers/cablings, transceivers, patch-cords, all necessary boards, power supplies, master control stations, initiating stations, receptacles, special mounting boxes, loudspeakers, terminal boards, cable, connectors, and accessories for a complete and operational VCS.
4. All VCS power and data cabling shall be encapsulated in point-to-point conduit for exterior applications. All raceways, pull boxes, standard boxes, (and special boxes provided by the VCS manufacturer), shall be provided. All VCS devices installed on the exterior of the building shall be connected via fiber opticcable.
5. The VCS system shall support self-diagnostics. The systems shall be capable of testing each station, wire cable, circuitry, microphone and speaker functionality at each unit based on a set time of day schedule.

    a. Diagnostics shall support report output in .pdf format.

6. The volume of each station shall be adjustable through the software and autonomously via a pick-up microphone, which will constantly monitor background noise and amplify speaker, microphone as required to facilitate communication intelligibility.
7. The intercom shall have background sound isolation, which will be removed background sounds to increase voice intelligibility at the master station.
8. The system shall be capable of automatic duplex, hands-free operation, without the use of handsets at the initiating station. The VCS systems shall interface to third party SMS peripherals via a TCP/IP, RS-232, RS-485 or RS-422 data interface or dry contact closure(s)/relays to denote the activation of a VCS initiating device. This interface shall be utilized to provide at minimum:

    a. ACMS notification
    b. Camera preset call-up.
    c. Monitor Call-up of camera presets.
    d. Event logging within the ACMS.

9. Annunciation

    a. Notification through the ACMS shall be achieved via the ACMS GUI as an on- screen icon and an audible tone from the master station(s).
        1) When the call button is pressed, at the initiating station, the initiating stations shall ring the security desk telephones and connect the desk phone being answered so that duplex/simultaneous communication can begin between the person placing the call and the person answering the call. The LCD display on the phone shall indicate the calling station location.

10. The VCS system shall comply with Electromagnetic Compatibility (EMC) standards EN55022 for electromagnetic emissions, and EN50082 for immunity.

    a. All system outputs shall be free of any noise such as pops, clicks, hiss, and hum at all times during operation of the system and shall be free of any audible distortion.

B. Door Stations

a. Door initiating stations shall be constructed of either high impact plastic or a metal enclosure. The Contractor shall coordinate installation of the initiating station prior to rough-in with the Owner/Architect.
b. The VCS shall provide the following functions:
1) The initiating station shall serve to provide clear, two-way, remote reply intercommunication between security and persons at entryways and allow remote door unlocking. The Contractor shall prevent interference such as HUM, crackle, delay/latency, etc.
2) Initiating stations shall be silk screened and furnished with a braille overlay with “Press button to call”.
a) Initiating stations shall comply with ADA requirements, including mounting height. Stations shall be provided with a 2-1/4” Braille plaque for ADA compliance.

3) Media gateways, converters, FXO ports shall be coordinated/provided by the Owner.
4) Door initiating stations shall have a means to remotely unlock doors via a Dual Tone Multi Frequency (DTMF) interface.
5) Each initiating station shall have a dedicated speech pathway.

2. Security

a. Intercom door stations shall be equipped with off-board tamper alarm, which shall additionally sever power to mechanical locking hardware.
b. Door station shall be equipped with stainless pin-in-hex or pin-in-torx button head screws.

3. Programming:
1) The Contractor shall provide all direct/indirect labor, inclusive of programming to support the routing of VCS Communication via the Owner’s phone system.

C. Cellular Backup

1. General

a. Provide a cellular backup transmitter, located in close proximity to the alarm panel.
b. The transmission antenna shall be located at a location with repeatability.
c. Coordinate with Owner carrier requirements.
d. Features
1) Have at minimum a 9” dipole antenna.
2) Shall be enclosed within a key-lockable and tamper resistant case. Case shall be equipped with a tamper-switch.
3) Battery backup shall be provided to support eight (8) hours of stand-by operation.

4) Unit shall be equipped with on board display (LEDs) to indicated system status and cellular signal strength.
5) 128bit AES (Advanced Encryption Standard) or equivalent shall be utilized for alarm signal authentication and security.

e. Support a variety of Carriers and formats inclusive of 4G/5G/LTE
1) The cellular backup shall be listed and certified as follows:
a) UL 365
UL 1610

UL 1635

UL 864

UL 1641

2. Firmware shall be remotely or locally flashed to support future changes to cellular network protocols.

D. Cellular backup shall be manufactured by Telguard, Sierra Uplink or Owner approved equivalent.

2.7 VIDEO MANAGEMENT SYSTEM (VMS)

A. The Contractor shall provide a digital, TCP/IP based VMS system, which shall include any and all equipment/peripherals, licenses as required to facilitate the functionality and operation desired.

1. Requirements

a. Camera housing colors shall match the surface to which they are being affixed. The Contractor shall coordinate the exact pantone color with the Architect, prior to ordering any surveillance equipment.
b. The NVR shall be ONVIF compliant and seamlessly integrate through an Application Program Interface (API), Software Development Kit (SDK) to the ACMS.
c. Cameras shall be powered by an Owner provided network switch utilizing the network cable. Power injectors (midspans) shall be provided by the contractor when required for proper operation.
d. Grounding per the Electrical and Telecommunication divisions. Refer to electrical and telecommunication divisions for additional detail.
e. NVR/Camera devices that require annuity licensing/costs shall not be acceptable and total annuity costs incurred will be the burden of the Contractor.

2. System Security

a. VMS systems shall be equipped with methods/protocols to preclude unauthorized remote access.

1) All peripherals shall have unique passwords, which shall include alpha numeric combinations with uppercase, lowercase and symbols. Passwords shall not be less than eight characters and shall independent of each camera.
2) The Contractor shall coordinate and advise the Owner on other additional precautions that could be utilized to preclude unauthorized access to TCP/IP cameras. Some precautions include but are not limited to the provisioning of: Virtual Private Networking (VPN), Subnet protocol, port filtering, static IP addressing, MAC filtering, SSL/TLS and of network intrusion detection systems/software, HTTPS encryption, IEEE 802.1Xa, network access control, digest authentication, user, access log, centralized certificate management or proxy servers.

b. Lens Optics
1) Lens focal lengths shall be coordinated with the Owner based on the field of views required by the Owner. Selected optics shall be designed for the transmission of digital/analog images and shall be coated, color corrected/Infra-red corrected, aspherical with low dispersion.
a) Lenses shall be either C or CS type and shall be varifocal with an automatic iris.

B. Network Video Recorders (NVR) Storage

1. The VMS shall be a computer networked device purpose built exclusively for the capture and processing of digital video and shall support live and pre-recorded viewing. The VMS software shall have a Client-Server based architecture that can be configured as a standalone VMS system with the Client software running on the NVR hardware and/or the Client running on any network connected TCP/IP PC workstation. Multiple client workstations shall be capable of simultaneously viewing live and/or recorded video from a single or multiple NVR's
2. The NVR platform shall be mounted in a standard 19" equipment rack.
3. NVR Storage

a. Without additional software or licensing The NVR shall be capable of:
1) Motion activated/conditional refresh:
a) Twenty (20) frames/Images per second, per camera. The system shall maintain all recorded video for a minimum of thirty days (30) days at a recording resolution not less than 2.0 megapixels / 1080P (1920 X 1080).
a) A reference frame shall be captured, not less than ever second for every camera, regardless if motion is detected.

2) Size storage for an additional 30% expansion beyond requirements identified herein.

b. The contractor shall provide RAID-5 storage, configured and sized as identified herein. The Contractor shall purchase any additional equipment/hardware, servers, software licenses, direct/indirect labor and other pertinent requirements to facilitate a seamless installation of the VMS.

4. The Network Video Recorder (NVR) shall be manufactured by Genetec, or Owner approved equivalent.

C. Workstation

1. The Contractor shall provide workstations as indicated on the drawings, which shall comply with the computer hardware requirements identified herein.

D. Megapixel Cameras

1. General

a. Unless superseded herein, all cameras shall have a minimum digital resolution capability of 2 megapixels minimum for individual non-stitched video fields of view.
b. Provide coordinated fields of view and usable images where people, objects, colors that are within the cameras field of view are readably discernible.
c. The Contractor shall provide the earlies model number/version for the cameras identified herein and as annotated on the drawings.
d. Cameras shall be fully compatible with the NVR system being specified. Cameras without manufactured approved Software Development Kits (SDK) and proven, verified Application Program Interfaces (APIs) or that are not ONVIF compliant shall not be allowed.
e. Cameras provided shall be rated for the environments where they shall be installed.
f. Housing shall incorporate thermostatically controlled heating element and air circulation as rated by the manufacturer for continuous operation in ambient temperatures of minus 30 to plus 120 degrees F dry bulb and up to 85 percent relative humidity.
g. The camera mounting shall be sufficient to prevent the mount from being pried from the mounting surface.
h. Power Over Ethernet (POE) integrated RJ-45 10-base TX (10/100) auto sensing network interface, with the following certifications: IEEE 802.3af, IPv4 (RFC 791), IPv6 (RFC 2460), QoS – DiffServ (RFC 2475).
i. The Contractor shall coordinate network requirements inclusive of IP addresses, network environment that shall be confirmed by the Owner, prior to final connection to the network.
j. Cameras shall utilize fixed IP addresses/dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server and in accordance to the Owner's network environment.

k. Exterior cameras, where required, shall allocate their power from an individually fused power supply or local 110v source.
l. As required, the Contractor shall provide a backlight compensating cameras to support useable video in instances of a bright foreground, and dark background

2. Cameras shall be:

a. ONVIF compliant and support a variety of standardized CODECS, which must include: MJPEG, MPEG-4, MPEG, H.264 and must be H.265 ready.
1) Support multi-cast streams in a variety of bandwidths and resolutions simultaneously.
2) Camera shall support the following protocols: TCP/IP, UDP/IP, FTP, SMTP, HTTP, DHCP, DNS, DDNS, NTP, SNMP, unicast, multicast.

b. Edge storage
1) Camera shall support continuous and event-controlled recording to: local Solid-State Density (SSD) memory via a SD-card

c. Tamper screws (pin-in-hex or pin-in-torx button head screws).
d. shall be provided on all camera and a tool shall be provide to the Owner to service the cameras.
e. Cameras shall be installed in accordance to the environments they are being installed. In addition to inclement weather, the Contractor shall securely fasten/mount cameras to the surface they are being mounted to.

3. Cameras models shall be most up to date Axis manufactured models or Owner approved equivalent.
4. Cameras shall be fully supported and compatible with the NVR and shall be manufactured by Axis or Owner approved equivalent.
5. Mounts

a. Camera mounts shall be provided as required. Mounts shall be properly fasted to the surface they are being affixed. Conduit within finished spaces of the building, service corridors, and docks shall be concealed. All mounting shall be pursuant to manufacturer requirements.
b. Mounting
1) Interior: Interior mounting within finished spaces shall be low-profile and recessed into the wall or ceiling. When mounting in the ceiling, safety chains/cable shall be provided and attached to a building structure.
2) Exterior: Unfinished spaces shall be surface mounted, and conduit shall be painted to match the material the camera is being affixed to.
3) Light/stanchion mounting: As identified on the security drawings, integrate camera mounting with stanchion coordinate Effective Projected Area (EPA) with stanchions being provided. Refer to details for additional information.

6. Multi-Sensor Camera

a. Multi-sensor cameras shall be provided as shown on the drawings and feature 180°/360° fields of view via three (3) to seven (7) separate megapixel imager/lens assemblies that shall communicate via single dedicated network connection.
   1) Frame capture:
   a) 25/30 fps at 720p.
   b) 12.5/15 fps at 1080p.

b. Multi-sensor cameras shall be provided as shown on the drawings have the following features:
   1) Imager
   a) Multi-sensor camera(s) be solid-state and incorporate a CCD/CMOS 1/4th 1/3rd imager and digital corrected lens, which shall which shall support 1080P.
   a) Varifocal digitally corrected lens that allows 180° of tile and 360° of rotation within the camera housing.
   b) Image 1.0 LUX. The f-stop rating shall be 1.2/1.4 at 70% reflectance. For this section, a usable image shall be where object and colors within the cameras view are readably discernible.

7. Manufacturers for UPS shall be Tripp lite, Schneider APC or Owner approved equivalent.

## 2.8 COMPUTER HARDWARE

A. General

1. Server

a. Minimum server requirements shall be maintained, unless superseded by the ACMS/VMS manufacturer.
b. Server with current version of Microsoft Windows Server OS.
   1) Xeon E3-1240 V5, 3.5 GHz, 8Mb cache, 4c/8T, 16 Gb UDIMM, 2400MT/s, ECC
   2) 4 1 TB SATA 6Gb/s AHCI/SMART Hard Drive(s)hot-plug hard drives RAID 5.
   3) Only newer Intel processors that accommodate for the Spectre/Meltdown vulnerabilities shall be permitted. Operating system patches that address these vulnerabilities shall not be acceptable.
   4) Four (4) USB 2.0 ports;
   5) Video Card with multiple video output;
   a) 280 GB/s Memory Bandwidth
   a) One (1) DVI/HDMI
   b) Interface; DVI-I, DVI-D, HDMI, Display-Port

c) Resolution & Refresh: 240Hz Max Refresh Rate; Digital: 4096 x 2160

6) 1000 MBPS Ethernet Network Interface Card;
7) Mouse;
a) Full function keyboard;
a) Audio sound card and speakers;
b) License agreement for all applicable software;

8) DVI LCD Monitor with mount:
a) 24" LCD Monitor

2. Workstation

a. Computer workstations and associated licenses for ACMS, VMS and VCS shall be provided as indicated on the security drawings. Computer workstations shall be configured and specified by the manufacturer, but shall include the following minimum requirements:
1) Operating System shall be Windows/LINUX based;
a) 3.6 GHz, 64-bit i7-8700/AMD Ryzen7 (1700x) multi core processor with 16GB of RAM; Bus Type: PCI-E 3.0
a) Only newer Intel processors that accommodate for the Spectre/Meltdown vulnerabilities shall be permitted. Operating system patches that address these vulnerabilities shall not be acceptable.

2) Four (4) USB 2.0 ports;
3) Video Card with multiple video output;
a) 280 GB/s Memory Bandwidth
a) Minimum of two (2) DVI/HDMI
b) Interface; DVI-I, DVI-D, HDMI, Display-Port
c) Resolution & Refresh: 240Hz Max Refresh Rate; Digital: 4096 x 2160

4) 1000 MBPS Ethernet Network Interface Card;
5) Single 500 GB SATA 6Gb/s SSD Hard Drive(s), AHCI/SMART compliant Hard drive with TRIM functionality.
a) Sequential hard drive read/write speeds not less than 500Mb/second

6) Mouse;
a) Full function keyboard;
a) Audio sound card and speakers;
b) License agreement for all applicable software;
c) 2400 x 600 dpi laser Report Text & Image Printer;

7) DVI LCD Monitor with mount:
a) 24" LCD Monitor

## 2.9 FIBER-OPTIC TRANSCEIVERS - ETHERNET

A. General

1. Contractor shall provide video transceivers, which shall be used to isolate copper connections from surge, voltage spikes or for when transmitting over extremely long distances.

    a. Provide single mode/multi-mode fiber optic cabling and associated fiber optic transceivers for all exterior peripherals.

2. The Contractor shall be responsible for the connection to power being provided, as required, supporting transceivers.
3. Where proprietary data connectivity is apparent and must be utilized, the Contractor shall provide and install the necessary converter or fiber optic receiver.

    a. The transceiver shall support the transmission of 10/100 Mbps employing single mode or multimode optical fiber and shall be IEEE 8023at/af compliant.
    b. The unit shall auto-negotiate data rates and half duplex or full duplex transmission.
        1) The module shall provide power and fiber link status indicating LED's for monitoring proper system operation.
            a) All LED indicators and both electrical and mechanical connections shall be identified with silk-screened labels.

4. Cable:

    a. Fiber shall be loose tube, buffered multimode/single mode and shall use 2 Fibers with LC connectors or SC connectors for outdoor/exterior environments.

5. Enclosure:

    a. Fiber optic transceivers shall be housed within enclosures rated for the environment that the transceiver shall be installed within. The enclosure shall be hinged and key lockable and keyed alike; key to be provided to Owner.
        1) Provide splice tray within enclosure, which shall have a splice/re-try loop path for slack/maintenance with lacing to secure fibers.

6. The Contractor shall provide and install a rack mounted fiber optic receiver distribution card frame within an equipment room for multiple fiber connections. A separate splice tray shall be provided for the fiber optic distribution frame.
7. Fiber-Optic Transceivers shall be Fibre Options, Interlogix, or Owner approved equivalent.

2.10 CONNECTORS/CABLE

A. General

1. Where required, by any prevailing code or standard the Contractor shall adhere to the rules governing their portion of work and manufacturer installation methodologies.

a. Conductors are minimums and shall be upsized to exceed or meet manufacturer guidelines/standards.
b. The Contractor shall adequately, within enclosures, support and neatly strap and label all cabling that shall be reflected in the submittals. The code shall refer to the end of line device as well as the type and gauge and termination point.
c. Firewall
1) Firewall penetrations/cores shall be accomplished by a sleeved piece of conduit sized 100% larger than what is required to meet future cabling requirements. Conduit shall be properly fire stopped according to local guidelines, where required.

d. Power
1) In all instances where low voltage power shall be supplied, the Contractor shall ensure that their engineering and voltage drop calculations shall not exceed or fall below minimum requirements for the operation of the equipment being provided.

e. Low voltage signal cable
1) SMS cabling
a) Cables utilized for low voltage security peripherals shall not be less than 16 AWG and increased as required.

2) Low voltage power cable
a) Low voltage lock power cabling shall not be less than 12 AWG and increased where required.

3) Connection
a) Twist-on connectors shall not be used, Crimp or other mechanical variety in instances for terminating multiple wires/resistors.

4) Ethernet
a) For all security peripherals, the Contractor shall provide certified, pre-tested patch cords in accordance with the Owner's IT standards and the telecommunications division.
b) In vertical riser conditions, the Contractor shall pull cable to a common wire trough, coiling the cable at each wire trough one (1) full revolution before continuing up to the next wire trough, unless otherwise directed by manufacturer or applicable code.

f. Fiber optic cable

1) Refer to telecommunications section
2) When optical fiber is utilized, two (2) pairs shall be pulled for connectivity at each location This will provide a back-up cable in the event of damage to the fiber optic filament.
3) Cable shall meet or exceed TIA 568C.3 (ISO 11801 OM3) performance criteria as defined by the referenced TIA/EIA documents.
4) All Fiber optic cable shall meet the following requirements:
a) Be dielectric materials (no conductive materials).
a) Incorporate water-blocking tape.
b) Be suitable for outdoor installation in underground conduit and in inner duct.
c) Outdoor fiber optic cable shall be buffer type: loose tube gel-filled buffer.
d) Jacket Material: PVC Jacket Color: Orange
e) Cable Rating: OFNR

g. Horizontal Low Voltage Ethernet Cabling / Modular Jacks
1) Low voltage Category 6 network cabling shall be provided for indoor security peripherals. All cables, termination components, and support hardware shall be provided by the Contractor.
2) Category 6 network cabling shall be per manufacturer requirements and certified 22-26 AWG stranded or solid conductors.
3) Outdoor cabling, which is not anticipated shall be coordinated with SB, but shall be isolated via fiber optic cable.
4) Cable shall be suitable for installation free air, in building risers, in conduit, and/or in cable tray and, where required, hold a CMP rating.
5) Provide 6’ of slack for each cable in accessible enclosure at each device location. Secure cable slack–coiled from 100% to 200% of the cable recommended minimum bend radius– (Velcro wrapped).
6) The jacket color for all network cabling for security peripherals shall be yellow.

h. Modular Jack/Patch ports
1) Low voltage ethernet cabling shall terminate via modular jack/modular patch panel, which shall be located at the peripheral or in the equipment room. Contractor shall coordinate wall space within equipment room to accommodate patch panel and equipment rack.
2) Contact plating shall be a minimum of 50 micro inches of gold in the contact area over 50 micro-inches of nickel, compliant with FCC part 68.5.
3) Data jacks shall be non-keyed 8-pin modular jacks. Cable shall be installed so pair twist(s) are as close the point of mechanical termination.
4) Modular jack contact(s) shall be rated/certified for 1000 RJ-45 insertions.

5) Jacks shall be compatible with EIA/TIA 606 color code labelingand accept snap on icons for identification or designation of applications.
6) Jacks shall be marked/identified for the wiring termination used T568A or T568B wiring.

2.11 LAEBLEING/TAGS

A. All points of connection under the Contractors' scope of work shall be labeled/tagged. In instances existing labels/tags are observed, the Contractor shall verify labels/tags with the identified connection point. All labels/tags shall correlate with the final updated as-built drawings. Labels/tags shall not be handwritten; all labels shall be either anodized aluminum or vinyl printed using a software program. Labels/tags applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label. All label material shall be legible and in accordance with UL969:

1. Cabling

a. Cabling shall be labeled/tagged at points of connection/termination and mechanical splices (as allowed). Labels/tags applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.

2. Anodized Aluminum Tags

a. Anodized, self-adhering tags shall be placed on access control readers and access control panels. Tags shall correlate device ID with as-built drawings.

3. Panels

a. Panels, Equipment Racks, Riser cable bundles.
1) All panels and other enclosures located in equipment rooms associated to the Contractors Work shall be labeled.
2) All cable connections within the panel shall be vinyl printed and labeled.
3) Information to be contained on labels shall include:
a) Device name
a) Room number
b) Panel connection/input panel address
c) Network address/device address/logical input address
d) Battery installed date

4. Modular Jack/Patch Ports

a. Modular Jack/Patch ports shall be labeled/tagged from port to switch location, I.e. S001-P023 = Switch 1 Port 23

## 2.12 TESTING

A. All Contractor provided cabling shall be 100% fault free unless otherwise noted. If any Link is found to be outside specification defined herein, identify and correct problem up to and including replacement of cable and associated termination(s).

1. Signal Line Cable Testing

a. Verification/wire mapping: Testing shall be done by the Contactor to detect continuity, shorts, opens, and miswiring, cross-connections and split pairs.

B. Network Cabling

1. In addition to the requirements for signal line cable testing, the Contractor shall also perform Transmission testing on computer network (category rated cable)

a. Contractor shall provide complete certification of cable, which shall be tested according to ANSI/TIA/EIA-568-B.1. Test parameters include wire map plus ScTP shield continuity (when present), length, NEXT loss (pair-to-pair), NEXT loss (power sum), ELFEXT loss (pair-to-pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew and length.

2. If no template is available, enter cable parameters for the cable per manufacturer's product data.

C. Testing equipment

1. All balanced twisted-pair field testers shall be factory calibrated each calendar year by the field test equipment manufacturer. The calibration certificate shall be provided for review prior to the start of testing.

D. Mechanical Splices:

1. Mechanical splices or terminal blocks shall be made for all wire terminations, except EOL resistors.
2. The Contractor may not use twist caps as an acceptable means of connecting two wires together. Terminal blocks, if used shall be housed in a NEMA or Hoffman lockable enclosure with a tamper switch connected to the access control system.

E. Acceptable manufacturers for low voltage-based cabling shall be Belden, West Penn, Berk- Tek, Draka, or equivalent.

## 2.13 RACEWAY

A. General

1. The Contractor shall provide horizontal and vertical conduit stubs for all security management system device and future devices, identified on the security drawings and details. At a minimum, conduit shall extend from the device 1'-0" into the ceiling cavity, where it shall continue in point to point conduit cabling back to the nearest electrical room. Exclusions include:
2. Cabling/conduit shall be concealed. In instances where conduit cannot be concealed, the Contractor shall paint the conduit to match the surface that the conduit is affixed to.
3. Cabling shall not be painted.
4. All exterior/buried cabling shall be encapsulated in conduit into the interior of the building and back to the nearest security equipment room.
5. Contractor shall coordinate routing with other trades, such as, but not limited to: irrigation, landscaping, civil, etc.
6. Contractor will determine the routing, size, and termination points from the security device for all horizontal and vertical conduit runs. The Contractor will also be responsible for providing all specialty junction boxes for security devices and performing all work necessary, such that at the completion of his/her work all space is restored to the original existing condition prior to the commencement of work.
7. Conduit sizing requirements shall be pursuant to standards such as BICSI, NEC, and others as applicable.
8. All horizontal and vertical cable runs between wire troughs/electrical/security equipment rooms shall be encapsulated in conduit, sized as required.
9. Cabling management, if required, shall be coordinated with the Owner, prior to installation.
10. The Contractor shall not damage the shield, cable or outer jacket. Cables shall be pulled in accordance with manufacturer guidelines to prevent damage to cable.
11. J-hook fill capacities shall be per manufacturer's recommendations and shall consider
12. diameter of cable type(s) being installed.
13. J-hook fill capacities shall be based on initially installed quantity of cable plus 50%.
14. Follow manufacturer's recommendations for allowable fill capacity for each size cable rings / J-hooks cable support.
15. Low voltage signal cable shall not be run near light ballasts.
16. The Contractor shall provide horizontal/vertical conduit/stubs as required for all SMS communication/power cable in accordance with the security system drawings, construction documents, electrical division, local and related owner requirements.
17. Conduit shall be point-to-point for all public spaces, which include, but are not limited to: main mall, garage areas and all exterior environments. Network cabling inside the project does not have to be in conduit unless required by code or:
18. Conduit shall be required for any fire barriers. All penetration, and conduit shall be fire stopped in accordance with NFPA codes. Open cable shall not be permissible through wall/fire barriers.
19. Conduit shall be concealed. In instances where conduit cannot be concealed in public areas, the Contractor shall paint the conduit to match the surface that the conduit is affixed to.

20. Conduit shall not to be routed through retail areas, unless specifically identified on the drawings, or absolutely necessary.
21. All exterior cabling shall be encapsulated in conduit into the interior back-of-house space. Cabling from this exterior point shall continue point to point conduit back to the nearest security equipment room identified on the drawings. All Exterior conduit shall be provided with compression fittings and shall be IMC.
22. Coordinate any roof penetrations with Owner and the preferred roofing company to avoid any warranty violations. Prior to any penetration of roof membrane, obtain approval from Owner and the roofing contractor on locations and penetration sizes. Coordinate roof patching as soon as possible after the hole is made to avoid any water leaks into the building. Do not make any roof penetrations directly above telecom rooms.
23. New Conduit/re-use of conduit infrastructure shall be installed in accordance with NEC/low voltage requirements/codes. Refer to related sections for additional requirements.
24. Any perceived ambiguity in the raceway requirements or cable routing should be forwarded to the Architect in the form of a Request-For-Information (RFI). The Contractor shall not proceed with rough-in for these areas until formal written direction is provided.
25. Contractor shall determine the routing, size and termination points from the security device for all horizontal and vertical conduit runs. The Contractor shall also be responsible for providing all specialty junction boxes for security devices and performing all Work necessary such that at the completion of their Work, all space is restored to the original existing condition prior to the commencement of Work.
26. J-hook fill capacities shall be per manufacturer's recommendations and shall consider diameter of cable type(s) being installed. J-hook fill capacities shall be based on initially installed quantity of cable plus 50% expansion. Follow manufacturer's recommendations for allowable fill capacity for each size cable rings / J-hooks cable support.
27. Low voltage signal cable shall not be run near light ballasts.
28. Connectors/Cable
29. All camera cabling shall be installed in accordance with this section and the Telecommunications Divisions. The Contractor shall provide cabling as required for camera connectivity with exception to the cameras within elevators, which shall be via the elevator traveling cable.

## PART 3 - EXECUTION

### 3.1 WORK SEQUENCE

A. Coordinate schedule for execution of work performed under this section with Owner, Construction Manager, General Contractor, and other trades.

B. Disruption of Normal Operations

1. Contractor shall identify known on-site project work that may disrupt normal operations within the facility, and coordinate with Owner to determine which of the identified project work will disrupt normal operations. Owner shall have right of final determination on which identified project work will disrupt normal operations. Contractor shall collaborate with Owner to develop mutually agreeable action plans to mitigate disruption of normal facility operations to the greatest extent possible. Action plans may include, but not be limited to:

   a. Scheduling identified work to be executed during hours outside the facility's standard hours of operation, as defined by the Owner.
   b. Scheduling identified work to be executed on days outside the facility's standard days of operation, as defined by the Owner.

2. Contractor shall complete work sequence coordination with Owner prior to the commencement of work on site.

   a. Contractor shall include in their bid costs associated with performing disruptive on-site project work outside standard business days and hours.

## 3.2 BUILDING ACCESS

A. Arrange for necessary openings in building to allow for admittance of apparatus.

## 3.3 DAMAGE

A. Contractor shall report to the Architect/Engineer any existing damage or deleterious conditions found by the Contractor on site prior to Contractor's commencement of work on site, including, but not limited to damage to structure, floors, walls, ceilings, doors, windows, furnishings, equipment, etc. Contractor shall be solely responsible for costs associated with correcting any damage or deleterious conditions found in the project area that went unreported prior to the Contractor's commencement of work on site.

B. Contractor shall replace accessible ceiling tiles damaged during the execution of work performed under this section, including tiles in areas beyond construction limits. Replacement tiles provided shall precisely match manufacturer, part number, size, style, color, texture, etc. of damaged tiles.

## 3.4 DEMOLITION

A. Remove devices and equipment identified for demolition, and associated cabling, raceways, and pathways no longer used by existing devices and equipment to remain.

B. Turn materials removed over to Owner. Contractor shall recycle removed materials that the Owner does not wish to retain.

C. Abandoned Cable

1. Remove and recycle unused, undocumented, and otherwise "abandoned" cables prior to the completion of the project.

a. Refer to NEC Articles: 640, 645, 725, 760, 770, 800, 810, 820 and 830 and NFPA- 75, NFPA-76, and NFPA-90A for definition of Abandoned Cable.

2. Contractor shall coordinate with Owner on identification of abandoned cables.

## 3.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division 01 for additional information and requirements.

B. Transport and handle materials in a manner that preserves their original condition as delivered from the manufacturer, is consistent with manufacturer's guidelines and instructions, and maintains applicable manufacturer warranties. Where applicable, lift only with lugs provided for the purpose.

C. Maintain manufacturer's original material packaging and shipping packaging until material is installed.

D. Store materials in a clean, dry, secure, temperature-controlled, humidity-controlled location in a manner that preserves their original condition as delivered from the manufacturer, is consistent with manufacturer's guidelines and instructions and maintains applicable manufacturer warranties. Protect stored material from deleterious substances, agents, conditions, etc. including, but not limited to, dust, dirt, debris, moisture, chemicals, chemical compounds, corrosion, temperatures and humidity outside material's published tolerance range, etc. and from damage due to intentional or incidental contact, vandalism, neglect, etc.

E. Contractor shall include in their bid costs associated with delivering, storing, and handling materials.

## 3.6 CLEANING AND REPAIR OF EXISTING MATERIALS

A. Where existing materials are specified to be reused, clean and repair those existing materials before placing back into service as necessary to guarantee like-new operation.

## 3.7 CONTINUITY OF EXISTING SERVICES

A. No existing active service shall be interrupted, changed, or terminated without written permission from Architect/Engineer and Owner. Obtain written permission prior to commencement of any work on or that may affect existing services.

B. When execution of work under this section may interrupt existing active services, or when existing active services need to be interrupted as part of execution of work under this section, Contractor shall notify Architect/Engineer, Owner, and other affected parties a minimum of four (4) weeks prior to commencement of any work affecting those existing services and coordinate a mutually-agreed-upon schedule for completing that work.

## 3.8 LOCATIONS OF WORK

A. Field-verify locations, elevations, and measurements prior to installation of materials.

B. Device locations shown on the drawings are diagrammatic and shall not be used for dimensioning of final location. Field-coordinate locations, elevations, and measurements with Owner and with other trades prior to installation of materials.

1. Where architectural features govern location of work, refer to Architectural contract documents. Where work by another trade govern location of work, refer to the contract documents of the other trade. Check, verify, and coordinate work with drawings and specifications prepared for other trades and include modifications, relocations, adjustments, etc. necessary to complete work and to avoid interference with other trades.
2. Included in this contract are connections to equipment provided by others. Refer to contract documents issued by other trades, including, but not limited to, Architectural, Electrical, Integrated Automation, Mechanical, and Technology, and to final shop drawings for equipment being furnished under other sections for exact locations of outlets, devices, and various connections required.

C. Locate devices and equipment to fit details, panels, decorating, or finish at space. Architect reserves right to make minor position changes of device and equipment locations before work has been installed.

D. Contractor shall survey the site and include in their bid costs associated with performing the work as specified in the contract documents.

E. Coordinate concrete work with electrical raceway/junction boxes.

F. Where conditions on site require adjustments to indicated locations and/or arrangements of devices, equipment, etc., Contractor shall make required changes at no additional cost to the Owner.

## 3.9 EQUIPMENT ACCESS

A. Install raceways, junction and pull boxes, and accessories to permit access to devices and equipment for maintenance after completion of project. Contractor shall relocate raceways or accessories as required to provide access to equipment post installation.

1. Install devices and equipment with ample space allowed for removal, repair, or changes. Provide ready accessibility to devices, equipment, and wiring without moving other devices or equipment which is yet to be installed or which is already in place.

B. Access Hatch

1. In coordination with the Architect's Reflected Ceiling Plan (RCP), Provide access hatch on the secured side of the door (opposite of card reader) where equipment requiring access for servicing, repairs, and maintenance would be otherwise concealed in walls, chases, inaccessible ceilings, etc.

a. Where reflected ceiling plans do not reflect access hatches, coordinate with Architect, prior to rough-in.

2. Coordinate required locations, sizes, and rough-in dimensions with Architect, prior to rough-in.

a. At a minimum, access doors shall be:
1) Of a style applicable to and compatible with surrounding surfaces.
2) Prime-coated steel, where not subject to excessive moisture.
3) Stainless steel in ceramic tile walls, toilet rooms, locker rooms, and areas subject to excessive moisture.
4) UL-listed, where installed in fire-rated construction.
5) Of sufficient size to allow for total maintenance.

## 3.10 EQUIPMENT SUPPORTS

A. Provide supporting steel not indicated on drawings as required for installation of equipment and materials including angles, channels, beams, hangers.

B. Concrete anchors used for attachment to concrete shall be steel shell with plug type. Plastic, rawhide or anchors utilizing lead are not allowed.

C. Do not support equipment or cable pathways from metal roof decking.

## 3.11 SUPPORT PROTECTION

A. In occupied areas, mechanical rooms and areas requiring normal maintenance access, certain equipment must be guarded to protect personnel from injury.

1. Provide minimum 1/2" thick Armstrong Armaflex insulation or similar product applied with Armstrong 520 adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft above floors, platforms or catwalks in these areas.
2. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

## 3.12 CUTTING AND PATCHING

A. Refer to General Conditions of Contract and Division 01 for additional information and requirements.

B. Perform cutting and patching required for complete installation of systems unless otherwise noted. Patch and restore damaged work to original condition, including openings remaining from removal or relocation of existing system components.

C. Provide materials required for patching unless otherwise noted.

D. Do not pierce beams or columns without permission of Architect and then only as directed. If openings are required through walls or floors where no sleeve has been provided, hole shall be core drilled to avoid unnecessary damage and structural weakening.

E. Where alterations disturb lawns, paving, walks, etc., or any other landscaping, replace, repair or refinish surfaces to condition existing prior to commencement of work, including affected areas beyond construction limits.

## 3.13 FLOOR, WALL, CEILING, AND ROOF OPENINGS

A. Coordinate location of openings, chases, furred spaces, etc. with appropriate Contractors. Provide during progress of construction sleeves and inserts that are to be built into structure.

B. Temporary sleeves used to form wall openings shall be removed prior to installation of permanent materials. Permanent sleeves for wall penetrations shall be minimum 24-gauge galvanized sheet metal unless otherwise noted.

C. Steel sleeves, when required, shall be Schedule 40 carbon steel pipe with integral water stop.

D. Size and location of core drilled holes shall be reviewed and approved by structural engineer prior to execution.

E. Submit product data and installation details for penetrations of building structure. Submittal shall include schedule indicating penetrating materials, (including steel conduit, PVC conduit, cables, cable tray), sizes of each, opening sizes and sealant products intended for use.

F. Where penetrations of fire- and/or smoke-rated assemblies are involved, seal penetrations with appropriate firestopping systems as specified in Division 26.

G. Submit complete penetration layout drawings showing openings in building structural members including floor slabs, bearing walls, shear walls. Indicate and locate, by dimension, required openings including those sleeved, formed or core drilled. Drawings shall be approved by the structural engineer prior to preparing openings in structural member.

H. Openings for penetrations shall be minimum 1/2" or larger on all sides than outside dimensions of raceways or cables. Where fire resistant penetrations are required, size openings in accordance with recommendations of firestopping systems manufacturer.

I. Seal non fire-rated floor penetrations with non-shrink grout equal to Embeco by Master Builders, or urethane caulk, as appropriate.

J. Seal non-rated wall openings with urethane caulk.

K. Where penetrations occur through exterior walls into building spaces, use steel sleeves with integral water stop, similar to type "WS" wall sleeves by Thunderline Corporation. Seal annular space between sleeves and pipe with "Link-Seal" modular wall and casing seals by Thunderline Corporation or sealing system by another manufacturer approved as equal by Architect/Engineer. Sealing system shall utilize Type 316 stainless steel bolts, washers and nuts.

L. Finish and trim penetrations as shown on details and as specified hereinafter.

M. Provide escutcheons where raceways pass through walls, floors or ceilings and are exposed in finished areas. Size escutcheons to fit raceways for finished appearance. Finished areas shall not include mechanical/electrical rooms, janitor's closets, storage rooms, etc., unless suspended ceilings are specified.

1. Coordinate color and finish of escutcheons with Architect. Escutcheons shall be chrome or nickel plated unless otherwise directed.

## 3.14 INSTALLATION

A. General

1. Work shall be performed in "neat and workmanlike" manner as defined in ANSI/NECA 1 "Standard Practices for Good Workmanship in Electrical Contracting".
2. Refer to manufacturer's product installation instructions, recommendations, and guidelines for additional information and requirements. Wherever a discrepancy is identified between Project Documents and manufacturer's product installation instructions, the more stringent requirement shall govern.
3. Cable, devices, equipment, etc. shall not be installed until building is enclosed and weather tight, and temperature and humidity conditions are controlled continuously and approximately the same as final conditions expected after occupancy.
4. Cable, devices, equipment, etc. shall not be installed in areas where installed materials would be exposed to moisture, dust, overspray, or other deleterious conditions.
5. Protect installed cable, devices, equipment, etc. from damage through completion of construction and date of Owner's final acceptance.

## 3.15 RACEWAY

### A. General

1. Contractor shall identify placement, connection, routing and sizing for all vertical and horizontal conduit indicated herein and as identified in the drawings and details. Conduit shall include any standard/specialty backboxes, and conduit that shall not be less than what is specified/identified but upsized as required by local code or manufacture installation criteria.

    a. Grossly oversized conduit sizes shall not be acceptable, and if identified shall be the burden of the contractor to correct.
    b. All conduit penetrations shall be fire stopped in accordance with NFPA codes. Open cable shall not be permissible through wall/fire barriers.
        1) Penetrations/cores shall be accomplished by a sleeved piece of conduit sized 100% larger than what is required to meet future cabling requirements. Conduit shall be properly fire stopped according to local guidelines, where required.
        2) Coordinate back box, plaster ring, raceway, junction box mounting and recessed/surface mounting requirements with Division 26 prior to the commencement of work on site.

    c. A Request-For-Information (RFI) should be created if there is any misunderstanding, ambiguity regarding raceway/cabling requirements.

2. Contractor acknowledges that areas of work may be partially or fully finished spaces, and any work shall be restored to the original condition prior to the work being started.
3. Coordinate backbox locations within concrete.
4. Raceways

a. Conduit
   1) Point-to-point concealed conduit shall be used from the device/peripheral to its termination point(s).
   2) Coordinate backbox locations within concrete.

b. Finished spaces
   1) Concealed conduit stubs shall extend from a the peripheral/backbox up to 8'-0" AFF that shall not be less than 1-0" AFF from the underside of the ceiling back to the nearest security equipment room.
   2) Cabling/conduit shall be concealed. In instances where conduit cannot be concealed, the Contractor shall notify the Owner/Architect for direction.

c. Unfinished spaces
   1) Exposed conduit stubs shall extend from a the peripheral/backbox up to 10'-0" AFF and via point to point conduit back to the nearest security equipment room.
   a) In instances the surface that the conduit is to be affixed to is painted, the conduit shall be painted to match.

d. Exterior
   1) All exterior cabling shall be encapsulated in IMC conduit.
   2) All exterior/buried cabling shall be encapsulated in conduit. Conduit stubs shall extend from a the peripheral/backbox up to 10'-0" AFF and via point to point conduit back to the nearest security equipment room.
   a) Contractor shall coordinate routing with other trades, such as: irrigation, landscaping, civil, etc.

e. Roof penetrations
   1) Any roof penetrations shall be coordinated with the Owner and their preferred roofing company, prior to penetration/rough-in.
   a) Obtain approval from Owner and the roofing contractor on locations and penetration sizes.

f. Intrinsically safe
   1) General
   a) An Intrinsically safe device shall withstand an explosion within the enclosure and allow escaping gas to cool as it expands and passes through the flame paths transiting from inside the enclosure to outside environment.

   2) Products
   a) As shown on drawings, the Contractor shall provide intrinsically safe equipment with current certifications by Factory Mutual, and U. L. Products that shall meet intrinsically safe requirements, shall be: Access control readers, request-to-exit buttons, cameras, locking hardware and similar.

g. Installation
   a) The intrinsic safety barrier shall be provided for protection against excessive mechanical and thermal stresses, dust, moisture and other contaminants and be installed in the safe area (outside the hazardous areas) only. Conduit shall extend into safe area and the barrier from the intrinsically safe device in accordance with the best practice of the trade.

B. Enclosure/Back Boxes

1. Enclosure penetrations shall be from the bottom unless the manufacturer requires penetrations from other directions.

   a. All penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water.

2. All specified box and conduit sizes are minimums. Size all boxes and conduits per applicable codes and manufacturer's requirements for all devices, connections, and associated wiring and cabling.

   a. Provide specialty back-boxes where required
   b. Provide safety chains for backboxes that are mounted with minimal support.

3. Coordinate back box, plaster ring, raceway, surface raceway, etc. pathway requirements with Division 26 prior to the commencement of work on site.
4. Where Division 28 device or equipment is provided with a device- or equipment-specific back box, Contractor shall provide that back box to Division 26 prior to commencement of rough-in work on site.
5. Coordinate backbox locations within precast concrete.
6. Other requirements

   a. All distributed panels/cabinets that house active electronics, relays, power distribution shall be lockable, keyed alike, and equipped with a tamper switch that shall be connected to the ACMS.

C. Cable

1. Cable shall be installed continuous and splice-free.
2. Installed cable shall be free of tension.
3. Cable installed shall be free of defects and damage. Protect cable from damage and visually inspect cable for damage or defects during installation. Provide permanent abrasion protection at points where cable contacts surface that could damage the cable.
4. Maintain manufacturer's published minimum bend radius. Provide permanent bend radius protection at points where cable changes direction.
5. Cable shall be installed parallel and perpendicular to major building lines.

6. Cable shall be kept clear of and protected from work by other trades. No cable shall be attached to or supported in any manner by work by other trades.
7. No cable shall be laid on accessible ceiling grid or tiles or attached or supported in any manner by accessible ceiling tiles, grid, or support wires.
8. No cable shall be fished bare through the interior of any enclosed, inaccessible ceiling, wall, or floor structures. Where such installation is required, fish flexible metallic conduit through the structure, secure the flexible metallic conduit at both ends and provide protective bushings at both ends of it, and install cable inside flexible metallic conduit.
9. To reduce the effects of electromagnetic interference (EMI), adhere to the following minimum separation distances:

    a. 5 inches from power lines of ≥ 2 kVA
    b. 18 inches from high voltage lighting (including fluorescent and LED)
        1) For LED lighting, stated separation distance shall be from cables to LED drivers

    c. 39 inches from power lines of ≥ 5kVA
    d. 47 inches from transformers and motors

D. Termination

1. Install and tighten connectors per manufacturer's instructions, using the appropriate tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, or equipment by over-tightening terminations.
2. Cable and conductor color coding shall be maintained consistent throughout the installation for each telecommunications outlet, device, and equipment type.
3. Provide a minimum of 12 inches of slack at each system device for future re-termination.

## 3.16 CONFIGURATION AND PROGRAMMING

A. Coordinate configuration and programming with Owner.

B. System hardware and software passwords shall be changed from manufacturer default passwords. Coordinate new passwords with Owner prior to commencement of programming work.

## 3.17 PAINTING:

A. Furnish equipment with factory applied prime finish unless otherwise specified.

B. If factory finish on equipment furnished by Contractor is damaged in shipment or during construction, refinish equipment per manufacturer's instructions and guidelines to satisfaction of Engineer.

C. Furnish one can of touch up paint for each factory finish, which will be final finished surface of product.

D. Painting of plywood in Communications Equipment Rooms shall be completed by Division 09 Contractor. Coordinate with Division 09 Contractor prior to the commencement of work on site.

## 3.18 CABLE AND CONDUCTOR PROTECTION

A. Protect cabling and termination components from contact with, and potential application of, foreign materials.

1. Foreign material is defined as material that is not part of cabling and/or conductor assembly, device, component, or equipment when delivered from manufacturer.
2. Examples include paint overspray and drywall compound.

B. Cabling and components that come into contact with foreign materials shall be replaced at no cost to project.

C. Solvents and other cleaning agents shall not be used to remove foreign materials that have already accumulated on cabling and components.

## 3.19 TESTING

A. General

1. Submit documentation of proposed testing procedures with shop drawings. Testing shall not proceed without approval by the Engineer. Failure to submit documentation of proposed testing procedures shall be grounds for Engineer or Owner to reject documentation of related testing and to require repeat of affected test at no additional cost to Owner. Documentation shall include:

    a. Description of each test
    b. Required test equipment for each test
    c. Pass/fail criteria for each test
    d. Sample test result forms

2. Owner and/or Engineer may, at their option, be in attendance to witness testing. Submit proposed schedule for acceptance testing to Owner and Engineer a minimum of ten (10) working days in advance to allow for their participation.
3. Conduct tests during course of construction when identifiable portion(s) of installation is complete.

    a. Alternatively, testing can be conducted after entire installation is complete if this does not delay project schedule.

4. Provide equipment and personnel necessary to conduct acceptance tests.
5. Where cable, devices, equipment, or systems fail to meet minimum test requirements, replace or repair defective work and/or materials as necessary at no additional cost to Owner and repeat inspection and test. Replacement materials shall be new.

B. Testing Cable

1. Refer to Section 27 1500 for information on and requirements for testing Category 5e/6/6A cabling.
2. Test installed cable in accordance with applicable standards and cable manufacturer's and equipment manufacturer's published requirements, guidelines, and best practices.
3. At a minimum, testing of installed cable shall include:

   a. Test for opens on each conductor
   b. Test for conductor-to conductor shorts, among all conductors
   c. Test for conductor to ground shorts, for each conductor (where applicable)

C. Testing Devices

1. Testing conducted shall verify proper operation of each feature and function of each device.
2. Testing conducted shall verify that each device has been configured and programmed in accordance with requirements of the project documents and Owner's direction.

D. Test Documentation

1. This Contractor is responsible for certifying, in writing, equipment and system test results. Certification shall include, but may not be limited to:

   a. Date and time of test
   b. Name(s) and title(s) of personnel conducting test
   c. Identification of device or portion of system under test
   d. Test equipment used
   e. Pass/fail criteria
   f. Results of test
   g. Signature of personnel who conducted the test

2. Maintain copies of certified test results, including those for failed tests, at project site. At completion of project, include copies of test records and certifications in OEM Manuals.

## 3.20 START-UP

A. Systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation.

1. This includes "Owner-Furnished, Contractor-Installed" (OFCI) and "Contractor-Furnished, Contractor-Installed" (CFCI) systems and equipment.

B. Follow manufacturer's pre-start-up checkout, start-up, trouble shooting and adjustment procedures.

C. Contractor shall provide services of technician/installer knowledgeable in start-up and checkout of types of systems and equipment on project.

D. Provide start-up services, by manufacturer's representative where specified or where Contractor does not have qualified personnel.

E. Coordinate start-up with trades.

## 3.21 ATTIC STOCK

A. Within ten (10) business days of the date of substantial completion, Contractor shall deliver notice to the Owner that attic devices/spares are maintained for the Project.

1. Attic stock materials shall be provided new, in manufacturer’s original, unopened packaging.
2. A complete inventory of attic stock materials provided shall be included with the attic stock materials. Inventory shall include manufacturer name, manufacturer part number, item name, item description, and quantity provided for each item.
3. Attic stock shall be maintained for long-lead items, only (e.g. access control panels/modules), and shall be maintained by the Contractor during the warranty period.

a. The Contractor shall be solely responsible for ensuring that parts are on-hand to repair/restore operation in accordance with the specification.

## 3.22 DOCUMENTATION

A. Refer to Division 01 for additional information and requirements.

B. Refer to individual technical sections for additional information and requirements.

C. Refer to 280000 - 1.9 - C - Operation and Maintenance Manuals and 280000 - 1.9 - D - Record Drawings for additional information and requirements.

D. Within five (5) working days of completion of each testing phase (e.g., building, area, floor, section, subsystem, etc.), Contractor shall submit draft record drawings and draft test result documentation for that testing phase.

1. Contractor shall schedule and coordinate testing phases to be complete a minimum of fifteen (15) working days prior to scheduled occupancy of phase area, such that the Architect/Engineer and Owner have a minimum of ten (10) working days to review draft test results and the Owner has a minimum of ten (10) working days to prepare the phase area for occupancy.
2. Engineer or Owner may request that 10% random re-test be conducted on system cable and/or devices - at no additional cost - to verify documented findings. Tests shall be a repeat of those defined above and in technical sections.

    a. Owner may also perform independent testing to verify results.
    b. If findings contradict documentation submitted by Contractor, additional testing can be requested to extent determined necessary by Engineer or Owner, including 100% re-test. This re-test shall be at no additional cost to Owner.

3. Draft record drawings may include legible hand-written markings of actual device locations and unique alphanumeric identifiers as so labeled.

E. Within thirty (30) calendar days of completion of last testing phase (e.g., building, area, floor, section, subsystem, etc.), Contractor shall submit final versions of Operations and Maintenance Manuals and Record Drawings.

## 3.23 CLEANING

A. Refer to Division 01 for additional information and requirements.

B. Refer to individual technical sections for additional information and requirements specific to work under that section.

C. Contractor shall, periodically, throughout execution of work under this section on site and/or as directed by Architect/Engineer, Owner, or General Contractor, remove waste materials, trash, rubbish, debris, etc. generated by execution of work under this section from building and leave work areas broom clean.

D. After installation is complete and prior to Owner's final acceptance, Contractor shall clean work provided under this section.

1. Remove unused materials, tools, installation equipment, etc. from the site.
2. Devices, components, equipment, enclosures, junction boxes, pull boxes, etc. shall be clean and free of dust, dirt, debris, oil, grease, paint, and any other foreign material.
3. The interiors of equipment enclosures, junction boxes, pull boxes, etc. shall be clean and free of wire/cable scraps, pieces of wire/cable insulation, dust, dirt, debris, oil, grease, paint, and any other foreign material.

4. Remove temporary labels not used for instruction or operation.
5. Walls and floors of Electronic Safety and Security spaces and equipment rooms shall be clean and free of dust, dirt, debris, oil, grease, paint, and any other foreign material.
6. Remove and properly dispose of waste materials, trash, rubbish, debris, etc. generated by execution of work under this section.
7. Contractor's cleaning protocols shall not include use of any chemicals, compounds, or agents not approved by the material manufacturer for use on their product, that would damage installed materials in any way, or that would invalidate the manufacturer's warranty.

## 3.24 TRAINING

A. Refer to Division 01 for additional information and requirements.

B. Refer to individual technical sections for additional information and requirements specific to work under that section.

C. Contractor shall properly train the Owner's designated representative(s) on the systems provided as part of the work performed under this specification. Training shall include:

1. System topology
2. Products that constitute the installed system
3. Equipment room layouts
4. Location of devices, equipment, etc.
5. Labeling scheme logic and label formats
6. Core operating principles ("how it works")
7. Features and functionality
8. Proper operation
9. Identification of, recommended schedules for, and execution of required care and maintenance
10. Troubleshooting and fault diagnosis procedures
11. Remediation of common faults and repair / replacement of consumable and field-serviceable components
12. Operation and Maintenance Manuals and Record Documents
13. Test results
14. Applicable warranties
15. Identification of and contact information for manufacturer and supplier/distributor product support

D. Contractor shall provide comprehensive manuals, in electronic and printed form, prepared to provide a written version of specified instruction, and use these written manuals as reference materials during in-person verbal training sessions. Contractor shall provide the manuals in .pdf electronic form and provide one (1) printed, bound copy of the manuals for each Owner's designated representative attending in-person verbal training sessions, in addition to quantity specified to be provided as part of Operation and Maintenance Manuals.

E. In-person verbal training sessions shall include a walking tour component to observe the actual work in the facility and a "classroom" component based on the written manuals.

F. Contractor shall coordinate training schedules with Owner and Architect/Engineer. No training session shall be scheduled with less than ten (10) business days' advance notification for attendees.

G. Attendees shall include a minimum of six (6) Owner's designated representatives.

H. Training shall be held at Project Site and shall be conducted during normal working hours.

I. Owner may, at their option, videotape training session(s) for use as future refresher

J. materials for Owner's staff.

K. Refer to individual technical sections for minimum duration of in-person verbal training sessions specific to work under that section.

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**SECTION 28 31 11**

**DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM, CHICAGO CLASS I**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes Chicago Building Code compliant Class 1, zoned, non-coded, UL-certified, microprocessor-based, addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

B. Section Includes:

1. Combination Fire-alarm and Sprinkler Supervisory Systems Control Unit and Annunciator (Existing to be relocated)
2. System Smoke Detectors
3. Duct Smoke Detectors
4. Heat Detectors
5. Speaker and Visual Notification Appliances
6. Magnetic Door Holders
7. Addressable Interface Devices
8. Digital Alarm Communicator Transmitter
9. Trouble Bell and Test Switch Stations
10. Data Gathering Panels
11. Power Supplies/Battery Power Backup System

C. Related requirements:

1. Section 01 40 00 – Quality Requirements
2. Section 0178 23 – Operation and Maintenance Data
3. Section 01 73 00 – Execution
4. Section 01 78 39 – Project Record Documents
5. Section 08 71 00 – Door Hardware
6. Section 26 05 33 – Identification for Electrical Systems

### 1.3 REFERENCES

A. City of Chicago Building Code

B. Chicago Electrical Code

C. NFPA 72 National Fire Alarm and Signaling Code, 2016 Edition

D. NICET: National Institute for Certification in Engineering Technologies

E. UL 464 Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories

F. UL 521 Standard for Heat Detectors for Fire Protective Signaling Systems

G. UL 864 Standard for Control Units and Accessories for Fire Alarm System

1.4 DEFINITIONS

A. Definitions in NFPA 72 apply to Fire Alarm Terms used in this Section

B. AHJ: Authority having Jurisdiction

C. CCBC: City of Chicago Building Code

D. FAA: Fire Alarm Annunciator Panel

E. FCP: Fire Alarm Control Panel

F. NAC: Notification Appliances Circuit

G. IAC: Initiating Appliances Circuit

H. SLC: Signaling Line Circuit

I. CBT: City Fire Alarm Box Tie and Disconnect Panel

J. LED: Light-Emitting Diode

K. EEPROM: Electrically Erasable Programmable Read-Only Memory

1.5 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

B. This system shall be designed to combine the operational requirements of CCBC for standard Class I and residential occupancy class A-2 fire detection system, sprinkler supervisory system and ADA complaint voice communication system.

C. Supervisory sprinkler system shall be of the addressable type and shall be separately identified at the fire alarm control panel and remote annunciator.

D. Two channel one-way voice system shall provide general alarm transmission over the speakers and support multiplexed signal transmission and survivable network nodes as required by CCBC.

1.6 SUBMITTALS

A. General Submittal Requirements:

1. All submittals shall be approved by AHJ prior to the beginning of any work.
2. Shop Drawings shall be prepared by person with the following qualifications:

   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified fire-alarm technician, Level III minimum.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

D. Submission to AHJ: Submit detailed shop drawings in accordance with the AHJs procedures and requirements for the fire alarm plan review. Provide identical submittal to the Architect for review. Upon receipt of the comments from AHJ, submit a copy of all the annotated drawings or correction sheets to the Architect. Incorporate all comments into the detailed shop drawings and resubmit to AHJ until approval is obtained.

1. Include voltage drop calculations for notification appliance circuits.
2. Include battery-size calculations.
3. Include performance parameters and installation details for each type of detector, verifying that each type of detectors is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
4. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations
5. Include notification system service equipment layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
6. Format of the written sequence of operation shall be input/output matrix, no other formats will be reviewed.
7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
8. Include device addresses list with the location labeling as they will appear in the display of fire alarm control panel and annunciator. Coordinate with final system programming.
9. Include detailed elevation showing control panels and annunciator panels' layout and dimensions. Coordinate with architectural floor plan and indicate compliance with restricted mounting location. Show coordination with all panels and devices in that location.

E. Qualification Data: For qualified Installer.

F. Field quality-control reports.

G. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 Operation and Maintenance Data, include the following:

1. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
2. Record copy of site-specific software.
3. "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

    a. Frequency of testing of installed components.
    b. Frequency of inspection of installed components.
    c. Requirements and recommendations related to results of maintenance.
    d. Manufacturer's user training manuals.
    e. Manufacturer's required maintenance related to system warranty requirements.
    f. Abbreviated operating instructions for mounting at fire-alarm control unit.

H. Software and Firmware Operational Documentation.

1. Provide the following:

    a. Software operating and upgrade manuals.
    b. Program Software Backup: On magnetic media or compact disk, complete with data files.
    c. Device address list.
    d. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

E. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

F. The installer shall be regularly engaged in the design, installation, testing and servicing of fire detection and alarm notification system and provide evidence of at least five years of relevant experience.

H. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system panels and devices from single source from single manufacturer. When existing system extension is specified the components shall be compatible with, and operate as, an extension of existing system.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Art. 100, by a qualified testing agency, and marked for intended location and application.

J. Comply with CCBC, latest Edition.

K. Comply with Chicago Electrical Code.

L. Comply with NFPA 72, 2016 Edition.

## 1.8 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

## 1.9 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

## 1.10 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months commencing with Substantial Completion, using factory-authorized service representatives.

1. Basic services: Respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
2. Additional Services:

    a. Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing.
    b. Compensation for additional services must be agreed upon in writing prior to performing services.
    c. Provide in the 11$^{th}$ month of the 12 months commencing with Substantial Completion a Test, Inspect and Report of the fire alarm system.

3. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the 1 Year System Warranty contract, deliver to the owner a proposal to provide contract maintenance and repair services for an additional two-year term which includes labor rates for Year 2 and 3 of Warranty Period. The owner will be under no obligation to accept maintenance service contract renewal proposal.

## 1.11 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

## 1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire alarm system equipment and devices in original factory shipping cartons.

B. Handle fire alarm system equipment and devices to avoid damage.

C. Store fire alarm system equipment and devices indoors in clean, dry space with uniform temperature to prevent condensation. Protect fire alarm system equipment and devices from exposure to dirt, fumes, water, corrosive substances, and physical damage.

D. If stored in areas subject to weather, cover fire alarm system equipment and devices to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packaging and flammable materials; install electric heating of sufficient wattage to prevent condensation.

E. Install plastic covers on smoke detectors to protect from construction dust and debris. Remove covers only before final system testing.

## 1.13 WARRANTY

A. Warranty all materials, installation and workmanship for three (3) years from date of acceptance, unless otherwise specified. Provide a copy of the manufacturers' warranty with closeout documentation the operation and installation manuals as required in Section 01 78 39 Project Record Documents, and Section 01 78 23 Operation and Maintenance Data.

B. The System Supplier shall maintain a service organization with adequate spare parts stock within 50 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the Owner notifying the contractor.

## 1.14 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no less than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no less than 1 unit.

3. Detectors: Quantity equal to 10 percent of amount of each type installed, but no less than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no less than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamper proofed components.
6. Speaker and Visual Notification Appliances: One percent of each type installed, but not less than 1 unit of each type.
7. Fuses: Two of each type installed in the system.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. SimplexGrinnell LP; a Tyco International Company

2.2 SYSTEM OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual Stations
2. Heat Detectors
3. Smoke Detectors
4. Manual Fire Alarm Boxes
5. Pre-action Fire Protection System Activation
6. Automatic Sprinkler System Water Flow
7. Fire-Extinguishing System Operation
8. Fire Standpipe System
9. Fire Pump Running

B. Fire-alarm signal shall initiate the following actions:

1. Activate visual and audible voice signaling devices on selected levels/areas:

a. Strobes shall flash in all areas of the floor. All strobes shall be synchronized.
b. Activate system speakers and visual devices in residential units on selected levels.
c. Voice Communications Systems – activate Audio Channel One.
d. Voice Communications Manual Voice Paging Operation: Manual selection of Audio Speaker Selector Switch for floor(s) or All Call, and microphone 'Push-To-Talk' switch shall activate Audio Channel Two.

2. Transmit an alarm signal to the remote alarm receiving station and to fire department.
3. Unlock electric door locks in designated egress paths.
4. Release fire and smoke doors held open by magnetic door holders.

5. Transmit signal to the Building Automation System to switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
6. Recall elevators to primary or alternate recall floors.
7. Activate emergency lighting control.
8. Switch local audio systems into emergency mode.
9. Activate emergency shutoffs for gas and fuel supplies.
10. Record events in the system memory.
11. Indicate actuated alarm initiating device type, location and address at the local fire alarm control panel.
12. Indicate actuated alarm zone(s) on the fire alarm panel and fire alarm annunciator.

C. Supervisory signal initiation on FCP shall be by one or more of the following devices and actions:

1. Duct smoke detectors.
2. Water flow switch associated with sprinkler head in elevator pit.
3. Valve supervisory switch.
4. Low-air-pressure switch of a dry-pipe sprinkler system.
5. Fire-pump power failure, including a dead-phase or phase-reversal condition.

D. System trouble signal initiation on FCP shall be by one or more of the following devices and actions:

1. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
2. Loss of primary power at control unit.
3. Ground or a single break in control unit internal circuits.
4. Abnormal ac voltage at control unit.
5. Break in standby battery circuitry.
6. Failure of battery charging.
7. Abnormal position of any switch at control unit or annunciator.
8. Open circuits, shorts, and grounds in designated circuits.

E. System pathways survivability:

1. Comply with Chicago Electrical Code, art. 760.
2. Comply with NFPA 72.
3. Initiating Device Circuits: Class B.
4. Addressable Loop Signaling Line Circuits: Class A.

    a. Provide isolator module every 15 devices.
    b. Provide minimum one (1) addressable loop per floor.

5. Signaling Line Circuit (Network Data, Panels and Annunciators, both: initiating devices and notification appliances): Class X, Level 2.
6. Notification Appliance: Circuits: Class B.
7. Door holder Circuit: Class D.
8. Install no more than 50 addressable devices on each signaling line circuit.

F. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

G. Priority of Signals: Automatic response functions shall be accomplished by the first zone initiated:

1. Alarm functions resulting from initiation by the first zone shall not be altered by subsequent alarms.
2. An alarm signal shall be the highest priority.
3. Supervisory or trouble signals shall have second- and third-level priority.
4. Signals of a higher-level priority shall take precedence over signals of lower priority even though the lower priority condition occurred first.
5. Annunciate all alarm signals regardless of priority or order received.

H. Noninterfering Signals: Signal on one zone does not prevent the receipt of signals from any other zone:

1. All zones shall be manually resettable from the FCP after the initiating device or devices have been restored to normal.
2. Systems that require the use of batteries or battery backup for the programming function are not acceptable.

I. Voice /Alarm One Way communication system: For the purpose of occupant notification, this system shall be dual (2) Channel audio voice communication systems.

1. The voice channels shall be designed as follows:

   a. Channel One - Coded General Alarm Message.
   b. Channel Two –Voice Message.

2. Voice Communications Manual Voice Paging Operation: Manual selection of Audio Speaker Selector Switch for floor(s) or All Call, and microphone 'Push-To-Talk' switch.
3. Audio One-Way Voice Communications

   a. The voice communication system shall be dual (2) channel audio evacuation systems, to allow the ability to have eight simultaneous announcements/paging. The audio channels shall be designated as such:
      1) Continuous Evacuation tone/General Alarm Tone subject to approval by AHJ.
      2) Manual Paging.

   b. The system custom digital voice message shall provide a minimum of 100 minutes.
   c. System shall be configured to allow for "All Call" and selective voice paging from the main FCP and FAA.
   d. Status Annunciator: Indicate the status of various voice/alarm speaker zones.
   e. Provide as minimum one thirty (20) watt supervised audio amplifier per paging zone.
   f. The system shall be UL 464 listed Audio Evacuation System, end-to-end compliant with requirement for 520Hz Low frequency Tone. This includes the nodes, amplifiers and high-fidelity speakers.
   g. The system shall be using high-fidelity speakers with the following selectable sound performance levels: 81, 84, 87 and 90 dBA at 10 feet.
   h. The amplifier circuits shall be sized at 1 watt per speaker, plus 25% spare capacity.
   i. Speaker and strobe circuits shall be zoned by floor or as noted on plans, with isolating module on each circuit.

j. Audio evacuation system supervision:
   1) Each speaker zone, amplifier, preamplifier, and power supply shall be supervised for component or circuit failure.
   2) Detection of amplifier failure shall activate trouble light and audible signal at console and initiate trouble alarm on fire alarm system.
   3) Provide minimum of 1 circuit for each zone or area of distinct communication.

J. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall.

   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room or in the shaft located at the elevator controller.
   c. Water-flow switch associated with the sprinkler in the elevator pit.

2. The elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
3. Floor elevator lobby smoke detector shall cause the cars to move to the alternate recall floor.
4. Emergency recall operation shall notify the remote supervising station and Fire Department. It shall be annunciated at FAA.
5. Elevator recall system shall comply with the City of Chicago Building Code.

K. Fire Doors Interface: Provide addressable relay module controlled by smoke detectors at doors in fire barrier walls. Connect to fire-alarm system to release shutter in case of fire alarm.

L. Door Controls: Door hold-open devices shall be controlled by adjacent smoke detectors communicating with the fire-alarm system.

1. Architectural Hardware Supplier shall supply door hold open devices. Provide fire alarm relay contacts or modules.
2. Magnetic door holders shall not be served by battery power. Magnetic door holders shall be supplied from the FCP at 120 to 24 volts and shall be released on the failure of primary power.

## 2.3 FIRE ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. City of Chicago approved.
2. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

   a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.

3. Addressable initiation devices that communicate device identity and status.

    a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

4. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 2 line(s) of 80 characters, minimum:
2. Approved for use in City of Chicago.
3. Features:

    a. Local alarm/trouble sounders.
    b. Light emitting diode annunciator for the display of the following system operating parameters:
    c. System AC power normal.
    d. System Alarm condition.
    e. System Supervisory condition.
    f. System Trouble condition.
    g. Alarm silence.

4. Keypad: Full key operated alpha-numeric keypad. Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
5. Control keys for the following functions:

    a. Alarm/Trouble Acknowledgement
    b. Local alarm Silence
    c. System Reset
    d. Lamp Test

C. Sprinkler Supervisory System Supervision:

1. Each waterflow switch and associated tamper switch shall be assigned to a separate annunciator zone.
2. Each high/low air pressure supervisory switch shall be assigned to a separate annunciator zone.
3. Each waterflow switch shall be assigned to a separate annunciator zone.
4. Each high/low air pressure supervisory switch shall be assigned to a separate annunciator zone.
5. Valve tamper switches shall be assigned to separate annunciator zones as scheduled.
6. Refer to the fire protection drawings for quantity and location of waterflow switches and tamper switches. The waterflow switches and tamper switches are furnished and installed under Section 21 05 23 General Duty Valves for Fire Protection Piping.

D. Fire Pump Supervision: Provide status indication for:

1. Power failure.
2. Pump running.
3. Phase reversal.

E. Cabinet: Lockable steel enclosure:

1. Arrange panel so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure.
2. If more than a single unit is required to form a complete control panel, provide matching modular unit enclosures.
3. Size cabinets to accommodate all components and to allow ample gutter space for interconnection of panels as well as field wiring.
4. Identify each enclosure, each component and module by an engraved red laminated phenolic resin nameplate with not be less than 1-inch high lettering.
5. Provide spare space for 20% of future expansion.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a UL listed Central Station via two dedicated telephone lines, utilizing digital alarm communicator transmitter.

H. Audio Notification: Operation pattern shall be as directed by the City of Chicago Bureau of Fire Prevention.

I. Silencing at control panel: Switches shall provide capability for acknowledgment of alarm; supervisory, trouble, and other specified signals at the FCP; and capability to silence the local audible signal and light an LED (light emitting diode). Subsequent zone alarms shall cause the audible signal to sound again until silenced in turn by switch operation. Restoration to normal of alarm, supervisory, and trouble conditions shall extinguish the associated LED and cause the audible signal to sound again until the restoration is acknowledged by switch operation

J. Primary Power: 24-V dc obtained from 120-V ac service that is to be connected to the building source of the emergency power and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm communicator transmitter shall be powered by 24-V dc source.

1. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

L. Automatic Transfer Switch: Transfer the load to the battery without loss of signals or status indications in the event of failure of primary power.

M. Batteries: Sealed lead acid. Provide sufficient capacity to operate the complete system in normal or supervisory (nonalarm) mode for a period of 24 hours. Following this period of operation on battery power, the batteries shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 15 minutes.

N. Battery Charger: Solid state, fully automatic, variable charging rate type. Provide for 150 percent of the connected system load while maintaining the batteries at full charge. In the event batteries are fully discharged the charger shall recharge them fully within four hours. Charger output shall be supervised as part of system power supply supervision.

O. Surge Protection:

1. Install surge protectors recommended by control panel manufacturer. Install on all system wiring external to the building housing the control panel.

P. Independent Systems: Alarm and supervisory systems in FCP shall be completely separate and independent. The alarm initiating zone boards in the FCP shall consist of plug-in cards. Construction requiring removal of field wiring for module removal is not acceptable.

Q. Control Modules: Types and capacities to perform all functions of the fire alarm system. Provide local, visible, and audible signals to notify of any alarm, supervisory, and trouble condition. Provide each type of audible alarm with a distinctly different sound.

R. Indicating Lights: Provide individual LED devices for each zone. Provide an LED test switch for each FCP section that will illuminate all LED devices on that section of the control panel. Provide manual toggle test switches or push test-buttons that do not require a key to operate. Alarm and supervisory signals shall light a red LED of the associated zone. Trouble signals shall light an amber LED for the associated zone.

S. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions

T. Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm or trouble condition on the system still exists.

U. Addressable monitor and control points may be combined into logical groups or lists (in software) to the extent that such grouping does not detract from the required operation of the system, including resounding of signals subsequent to actuation of the signal silence switch. Systems which treat logical groups like hardwired/zones with respect to alarm/trouble resound are not acceptable.

## 2.4 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
6. When system smoke detector in the residential unit goes into alarm, all detectors in the same unit go into alarm. Supervisory signal is transmitted to FACP and displayed on FAA.

M. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

B. Duct Smoke Detectors: Photoelectric type.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status (normal, alarm or status).
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

3. One form C auxiliary alarm relay rated at 2 amps @ 30Vdc.
4. Sample tube can be installed with or without the cover place and be rotated in 45-degree increments to ensure proper alignment with duct airflow.
5. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector. Provide heated enclosure if duct detector is exposed to temperature below 32 Degrees F.
6. Each sensor shall have multiple levels of detection sensitivity.
7. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
8. Remote test station with alarm LED light key switch.
9. Cleaning of sampling tubes: access through duct housings front cover.

C. Combination Carbon Monoxide and Smoke Detectors:

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

3. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

4. Test button tests all sensors in the detector.

5. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present sensitivity selected.
   d. Sensor range (normal, dirty, etc.).

6. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.

   a. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
   b. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
   c. Heat sensor shall be as described in "Heat Detectors" Article.
   d. Each sensor shall be separately listed according to requirements for its detector type.

## 2.5 NONSYSTEM SMOKE DETECTORS

A. General Requirements for Nonsystem Smoke Detectors:

1. Nonsystem smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
2. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.
3. When non-system smoke detector in the residential unit goes into alarm, all detectors in the same unit go into alarm.

B. Single-Station Smoke Detectors:

1. Comply with UL 217; suitable for NFPA 101.
2. Operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
3. Auxiliary Relays: One Form A and C, both rated at 0.5 A.

4. Integral Audible Notification Appliance: Piezoelectric sounder generating low frequency tone 520 kHz with a sound level of at least 5 dB above the maximum sound level having a duration at least 60 sec. or a sound level of at least 75 dB, whichever is greater measurable at the pillow level in the respective area.
5. UL 464 listed.
6. Visible Notification Appliance: 177-cd strobe.
7. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.
8. Test Switch: Push to test; simulates smoke at rated obscuration.
9. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
10. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
11. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
12. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

C. Single-station combination smoke and carbon monoxide detectors:

1. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.

   a. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
   b. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
   c. Each sensor shall be separately listed according to requirements for its detector type.

2. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

3. Test button tests all sensors in the detector.

## 2.6 SYSTEM HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.7 SYSTEM CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

## 2.8 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated on drawings and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

1. Horns shall be field configurable for continuous, temporal, or march time pattern.
2. All horns operation shall be synchronized.

C. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to support the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: Flush or surface mounted as required by field conditions.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.
7. Notification appliances in residential units and elsewhere indicated in contract documents shall be able to generate low frequency tone 520 kHz with a sound level of at least 5 dB

above the maximum sound level having a duration at least 60 sec. or a sound level of at least 75 dB, whichever is greater measurable at the pillow level in the respective area.

D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

1. Rated Light Output: 15/30/75/110 cd, selectable in the field.
2. Visible notification appliances in residential units and elsewhere indicated in contract documents: 177 cd.
3. Mounting: Wall mounted unless otherwise indicated.
4. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
5. Flashing shall be in a temporal pattern, synchronized with other units.
6. Strobe Leads: Factory connected to screw terminals.
7. Mounting Faceplate: Factory finished, red.
8. Strobe circuit loading shall be calculated at 75cd tap for all devices, except in mechanical, interstitial spaces where circuit loading shall be calculated at 110 cd tap.
9. All strobes operation shall be synchronized.

E. Trouble Bells: Electric-vibrating, 4-inch diameter, 24-V dc, under-dome type; with provision for housing the operating mechanism behind the bell. Bells shall produce a sound-pressure level of 94 dBA, measured 10 feet from the bell. Provide weatherproof enclosure where indicated.

## 2.9 MAGNETIC DOOR HOLDERS

A.Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

a. Material and Finish: Match door hardware.

## 2.10 FAULT ISOLATOR MODULE

A.Provide Fault Isolator Module (FIM) on initiating device circuits for each 25 devices on a loop

B.Fault Isolator Module shall:

1. Automatically re-connect isolated section of loop upon correction of fault conditions.
2. Not require any address setting
3. Operations shall be totally automatic. It shall not be necessary to replace or reset FIM after its normal operation.

4. Include LED, which shall flash under normal operation and illuminate steady to indicate short circuit.

## 2.11 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.

## 2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Transmitter in this article is compatible with most central-station receiving equipment but verify specific compatibility and acceptability of this signal-transmission method for each project. Coordinate for availability of dual dedicated telephone lines.

B. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

C. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

D. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

E. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address and Zone of the supervisory signal.
3. Loss of ac supply or loss of power.
4. Low battery.
5. Abnormal test signal.
6. Communication bus failure.

F. Secondary Power: Integral rechargeable battery and automatic charger.

G. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 ELEVATOR INTERFACE CABINET

A. Lockable continuous hinge cover, UL listed red metal cabinet enclosure with dual screw barrier terminal strips for each interface point.

B. Provide word FIRE in white letters on the cover.

C. Include tamper switch to be monitored by the fire alarm systems.

D. Include the following:

1. Three intelligent relays (Primary Recall, Alternate Recall, Fire Hat).

E. Label all the relays and input modules for the function.

F. Provide separate interface cabinet for each elevator.

2.14 SPRINKLER SYSTEM AND DUCT SMOKE DETECTORS REMOTE INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light shall flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the valve is located. The identification plate also designates protected spaces downstream from the water-flow switch.

2.15 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.
2. Finish: Paint of color to match the protected device.

2.16 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with Chicago Electrical Code.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 14 AWG, size as recommended by system manufacturer.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 14 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.17 SPARE CAPACITY

A. Provide 20% spare capacity in all panels, annunciators, on every SLC and NAC for future expansion.

**PART 3 - EXECUTION**

3.1 EQUIPMENT INSTALLATION

A. Comply with City of Chicago Building Code and NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting: Mount fire-alarm control unit on the wall with bottoms of the cabinets not lower than 18 inches and tops of cabinets not more than 72 inches above the finished floor.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
4. Smooth ceiling spacing shall not exceed 30 feet.
5. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to NFPA 72.
6. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
7. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
8. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
9. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
10. Audible Alarm-Indicating Devices: Install not lower than 96” above finished floor and not less than 6 inches below the ceiling to the bottom of device. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
11. Visible Alarm-Indicating Devices and Combination Audio/Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and not lower than 80” above finished floor and not less than 6 inches below the ceiling to the bottom of device. Manual Stations
12. Operable part of manual stations shall be installed 48” above finished floor to the top of the device.

13. Install in unobstructed locations and within 5 feet from the doors where indicated on floor plans.
14. For surface mounting, use manufacture-supplied backboxes and trim plates.
15. Mark each device with its circuit number.
16. Device Location-Indicating Lights: Locate in public space near the device they monitor.
17. FCP and Annunciator: Install with top of panel not more than 72 inches above the finished floor.

## 3.2 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 08 71 00 Door Hardware. Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
10. Supervisory connections at fire-pump engine control panel.

## 3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 33 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

## 3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Architect and AHJ.

B. Perform tests and inspections. Comply with requirements of AHJ.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Initial test shall be performed in compliance with procedures established by AHJ and in presence of representatives of both City of Chicago Bureau of Fire Prevention and Electrical Inspection. Contractor shall schedule and pay all applicable fees and coordinate testing.
4. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
5. Test audible appliances for the private operating mode according to manufacturer's written instructions.
6. Test visible appliances for the public operating mode according to manufacturer's written instructions.
7. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. See Section 01 40 00 Quality Requirements, for retesting and re-inspecting requirements and Section 01 73 00 Execution, for requirements for correcting the Work.

E.Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F.Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

N. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

## 3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

**END OF SECTION**

# SECTION 31 10 00

# SITE CLEARING

## PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping, or sealing, removing site utilities and abandoning site utilities in place.
7. Temporary erosion and sedimentation control measures.

B. Related Requirements:

1. Section 01 35 62 “Erosion Sedimentation Control”.
2. Section 01 56 39 “Temporary Tree and Plant Protection”.
3. Section 01 74 19 “Construction Waste Management and Disposal”.
4. Section 31 22 14 “Earthwork”.
5. Section 31 23 18.13 “Subtitle D Waste Disposal”.
6. Section 31 23 18.14 “Clean Construction of Demolition Debris and Uncontaminated Soil”.
7. Section 31 23 23 “Acceptance of Backfill, Topsoil, & CU Structural Soil”.

1.03 DEFINITIONS

A. Clean Construction or Demolition Debris (CCDD): Per the Illinois administrative code, Title 35 Environmental Protection Subtitle J: **“**Clean Construction or Demolition Debris Chapter I: Pollution Control Board Part 1100 Clean Construction or Demolition Debris Fill Operations and Uncontaminated Soil Fill Operations Section 1100.103 Definitions”

***"Clean construction or demolition debris" means uncontaminated broken concrete without protruding metal bars, bricks, rock, stone, reclaimed or other asphalt pavement.*** For purposes of this Part, CCDD may include uncontaminated broken concrete without protruding metal bars, bricks, rock, stone, or reclaimed or other asphalt pavement that has been painted (painted CCDD) if the painted CCDD is used as fill material at a CCDD fill operation in accordance with Section

1100. 212. *Clean construction or demolition debris does not include uncontaminated soil generated during construction, remodeling, repair, and demolition of utilities, structures, and roads provided the uncontaminated soil is not commingled with any clean construction or demolition debris or other waste.* For purposes of this Part, uncontaminated soil may include incidental amounts of stone, rock, gravel, roots, and other vegetation. [415 ILCS 5/3.160(b)]"

B. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

C. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on the Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Site.

1. Review rock / topsoil stripping and stockpiling programs.

1.05 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain the CHA's property, cleared materials shall become Contractor's property and shall be removed from Project site in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal", Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," or Section 31 23 18.15 "Special, Non-Hazardous Special, and Hazardous Waste Soil Removal and Disposal," as applicable.

1.06 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Rock / topsoil stripping and or stockpile program.

C. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

D. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

1.07 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written or diagrammatic program for rock stockpiling and topsoil stripping and stockpiling in accordance with geotechnical investigation report and related specification sections.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedure and handle materials and equipment during the work. Include placement and protection at stockpiles within program description.

1.08 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the CHA and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by the CHA or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining CHA's property will be obtained by CHA before award of Contract.

1. Do not proceed with work on adjoining property until directed by CHA.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on CHA's premises. Confirm location with the CHA's Designated Representative.

D. City of Chicago Utility Locator Service: Notify D.I.G.G.E.R. a minimum of 48-Hrs in advance of demolition or construction site activities at 811 or 312.744.7000 for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

G. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.

3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

H. Do not direct vehicle or equipment exhaust towards protection zones.

I. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

J. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

## PART 2 - PRODUCTS

2.01 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earthwork."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

2. Imported soil material must comply with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil."

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #23 (surface-tolerant, anticorrosive metal primer).

## PART 3 - EXECUTION

3.01 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to CHA.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways,

according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

## 3.03 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to the Drawings and according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by CHA or according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

## 3.04 EXISTING UTILITIES

A. The CHA will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.
2. The CHA will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by CHA or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify the CHA not less than one week in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without CHA's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 02 41 19 "Selective Demolition."

3.05 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material in compliance with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil."

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.06 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Topsoil is defined as friable clay loam surface soil. Strip topsoil to depth 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
2. Strip topsoil to whatever depths encountered, and in such manner to prevent intermingling with the underlying subsoil or other objectionable material.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal", Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," or Section 31 23 18.15 “Special, Non-Hazardous Special, and Hazardous Waste Soil Removal and Disposal,” as applicable. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.07 STOCKPILING ROCK

A. Remove from construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to 36 inches.
2. Do not stockpile rock within protection zones.
3. Dispose of surplus rock in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal", Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," or "Section 01 74 19 "Construction Waste Management and Disposal", as applicable. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus rock to allow later use by the CHA.

## 3.08 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed

## 3.09 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off CHA's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

C. All surplus excavation, waste materials, and demolition debris shall be removed and disposed of off-site at a licensed landfill, recycling center, reused on site, or otherwise disposed of in accordance with local, state, and federal disposal laws and regulations, including the Illinois Environmental Protection Agency's (IEPA), and Section 31 23 18.13 "Subtitle D Waste Disposal", "Section 31 23 18.14 "Clean Construction of Demolition Debris and Uncontaminated Soil", 31 23 18.15 "Special, Non-Hazardous Special, and Hazardous Waste Soil Removal and Disposal" and/or Section 01 74 19 "Construction Waste Management and Disposal," as applicable.

**END OF SECTION**

# SECTION 31 22 14

# EARTHWORK

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes earthwork required to complete the Project except as specified in related work.

1. Removal and storage of topsoil
2. Rough grading
3. Finish grading
4. Excavating for building volume below grade, footings, pile caps, slabs-on-grade, paving, and site structures.
5. Trenching for utilities outside the building to utility main connections.
6. Excavation, backfill, grading, and finish grading for a synthetic grass or permeable paver surfacing system
7. Filling holes, pits, and excavations generated as a result of removal (demolition) operations

B. Related Requirements:

1. Section 01 35 62 “Erosion Sedimentation Control”.
2. Section 01 56 39 “Temporary Tree and Plant Protection”.
3. Section 31 10 00 “Site Clearing”.
4. Section 32 91 13 “Topsoil and Soil Preparation”.
5. Section 31 23 18.13 “Subtitle D Waste Disposal”.
6. Section 31 23 18.14 “Clean Construction of Demolition Debris and Uncontaminated Soil”.
7. Section 31 23 23 “Acceptance of Backfill, Top Soil, & CU Structural Soil”.

### 1.3 SUBMITTALS

A. Product Data: For soil and fill material from borrow sources that are proposed for use on the Project. Include source and gradation/sieve analysis for each material.

1. Imported Fill - Site History: Submit two copies of required documentation, including Sanborn maps, aerial photographs, and a regulatory database search for all soil materials brought onto the Site.

B. Product Data: Geotextile Fabric.

C. Samples

1. Topsoil: Conforming to State of Illinois, Highway Department standards.

   a. Topsoil may be excavated on site if it meets specified requirements.

2. Submit 10 lb samples of each material to be used. Identify source, type (use) of each material and gradation. Forward to Contractor's testing agency packed tightly in containers to prevent contamination. Submit copy of transmittal to Architect.

D. Copies of environmental analytical results of all backfill material, topsoil and CU Structural Soil verifying that these materials do not exceed APPENDIX B, SECTION 742, TABLE A; TIERED APPROACH TO CORRECTIVE ACTION OBJECTIVES (TACO): 35 ILL. ADM. CODE 742 values for 35 ILL. ADM. CODE 740 APPENDIX A Target Compound List (TCL) parameters in accordance with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil.". For samples from virgin sources, one representative sample must be analyzed for 35 ILL. ADM. CODE 740 APPENDIX A Target Compound List (TCL) parameters or the Contractor shall submit a certification letter from the CHA/Operator of the source that all imported material is virgin material mined directly from the source quarry. For samples from recycled sources, one sample per 1,000 tons of material must be analyzed for 35 ILL. ADM. CODE 740 APPENDIX A Target Compound List (TCL) parameters. For recycled sources, the Contractor must identify the source of the recycled material including the CHA, the address, imported fill environmental history, and a written demonstration that the property source is not in any regulated environmental related cleanup program. A copy of the analytical results shall be submitted at least one week prior to depositing backfill or topsoil on site. The date of the analysis shall be within 60 days of importing such material to a CHA property.

E. Materials Sources: Submit name of imported materials source.

1. Submit certificate, signed by the material supplier, certifying fill materials provided for the Project comply with the specified requirements, including gradation and environmental.
2. Submit directly invoices and delivery tickets indicating the amount and type of off-site materials delivered.

F. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

G. Submit sediment and erosion plan, specific to the site, that complies with EPA 832/R-92-005 "Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices" or City of Chicago requirement where more restrictive.

H. Qualifications: For Licensed Land Surveyor.

I. Final Survey: Submit two copies of the survey of the completed stone base, with elevations and slopes indicated

J. Submit Settlement monitoring reports as specified herein.

K. Submit Earthwork surveys as specified herein.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Perform Work in compliance with applicable requirements of governing authorities having jurisdiction including the City of Chicago.

B. Earthwork Contractor: Engage a firm experienced in excavating, backfilling, and grading.

C. Installer Qualifications: Engage a single firm experienced in the installation of granular bases similar in design and extent to those required for the Project, on not less than 5 projects of similar scope to that required for the Project in the last 3 years, and whose work has resulted in a record of successful in-service performance.

D. Soil Testing and Inspection Service:

1. The Contractor will engage a soil testing and inspection service, to include testing soil materials proposed for use in the Work and initial quality control testing during earthwork operations.
2. Furnish soil survey for satisfactory soil materials and samples of soil materials to the testing agency.

E. Surveyor: Engage a State of Illinois Licensed Land Surveyor to lay out the field, establish control points and boundaries, and lay out the limits of the Work.

F. Soil Testing and Inspection Service:

1. The Contractor will engage a soil testing and inspection service, to include testing soil materials proposed for use in the Work and initial quality control testing during earthwork operations.
2. Furnish soil survey for satisfactory soil materials and samples of soil materials to the testing service.

1.5 PROJECT CONDITIONS

A. Site Information

1. The CHA has had a subsurface investigation performed, the results of which are contained in a report. The report presents conclusions on the subsurface conditions based on their interpretation of the data obtained in the investigation.
2. The Contractor acknowledges that they have reviewed the report and any addenda thereto.
3. It is recognized that a subsurface investigation may not disclose all conditions as they actually exist and other conditions may change, particularly groundwater conditions, between the time of a subsurface investigation and the time of earthwork operations.
4. The data on indicated subsurface conditions are not intended as representations or warranties of the continuity of such conditions. It is expressly understood that the CHA and Architect will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. The data are made available for the convenience of the Contractor.
5. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the CHA.

B. Traffic: Conduct operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction.

C. Protection of Existing Improvements:

1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing improvements to remain in place.
2. Restore damaged improvements to their original condition, as acceptable to the CHAs and other parties or authorities having jurisdiction.

D. Protection of Existing Vegetation:

1. Protect existing vegetation to remain in place against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fences, barricades or guards as required to protect vegetation to be left standing.
2. Water as required to maintain health during the course of construction operations.
3. Protect root systems from damage due to noxious materials in solution caused by runoff or spillage during mixing and placement of construction materials, or drainage from stored materials. Protect root systems from flooding, erosion or excessive wetting resulting from dewatering operations.
4. Do not allow fires under or adjacent to plantings which are to remain.
5. Provide protection for roots over 1½" diameter that are cut during construction operations. Coat the cut faces with an emulsified asphalt or other acceptable coating especially formulated for horticultural use on cut or damaged plant tissues. Temporarily cover all exposed roots with wet burlap to prevent roots from drying out; provide earth cover as soon as possible.
6. Repair or replace vegetation damaged by construction operations, in a manner acceptable to the Architect/Engineer of Record.
7. Repair tree damage by a qualified tree surgeon. Replace trees, which cannot be repaired and restored to full-growth status, as determined by the tree surgeon at no cost to the CHA.

E. Improvements on Public Property: Obtain authority for performing removal and alteration Work on public property.

F. Existing Utilities:

1. Locate existing underground utilities in the areas of Work before starting earthwork operations. If utilities are to remain in place, provide adequate means of protection during earthwork operations.
2. Contact the CHA's Designated Representative to verify locations of existing underground utilities on site before starting excavation.
3. Contact D.I.G.G.E.R (312-744-7000) to verify locations of existing underground utilities before starting excavation.
4. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the Architect immediately for directions as to procedure.
5. Cooperate with the CHA and public and private utility companies in keeping their respective services and facilities in operation.

6. Demolish and completely remove from the site underground utilities indicated to be removed. Coordinate with local utility companies for shutoff of services if lines are active.

G. Use of Explosives: The use of explosives shall not be permitted.

H. Protection:

1. Protect existing improvements on and off the site from damages caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

I. Settlement Monitoring

1. Readings: Contractor shall have the surveyor take readings of the work and adjacent property at the minimum number of points indicated below. Additional monitoring points may be established as the Contractor determines to be necessary. Provide a proposed written program for settlement monitoring prior to start of excavation or foundation work. Record readings weekly until Preliminary Acceptance.

   a. Street and Pedestrian Pavement on Grade: 100 feet on center along each vehicular and pedestrian roadway and walkway; vertical control.
   b. For all adjacent properties, buildings, structures, curbs, walks, drives on all adjacent blocks, alleys, streets facing the Site: 2 points for each location horizontal and vertical control.
   c. Reports: The Contractor shall submit a written report to the CHA's Designated Representative and the Architect weekly.

J. Earthwork Surveys: The Contractor shall hire a professional land surveyor to perform the following:

1. Bottom of Excavation As-Built Survey

   a. Provide a bottom of excavation as-built survey with a maximum grid spacing of 25 feet for all soil remediation, soil undercuts, and foundation removal.
   b. Clearly delineate the perimeter, corners, and elevations of all locations in which foundations were removed and where authorized undercut areas were excavated.
   c. Survey to include spot elevations along perimeter and corners of the property lines/project boundary lines.
   d. Provide dimensions from property lines to benchmarks and to all undercut areas and excavation areas.
   e. Provide length and width dimensions for all undercut areas and excavation areas.
   f. Submit 1 electronic copy in PDF format and 3 full size hard copies, stamped by a Professional Land Surveyor, within 7 business days of completion of all demolition / excavation / export operations.
   g. For projects with construction durations greater than 30 calendar days, submit 1 electronic copy in PDF format monthly from construction start date to Preliminary Acceptance.

2. Top of Compacted Backfill and Fill As-built Survey

a. Provide a top of compacted backfill and fill as-built survey with a maximum grid spacing of 25 feet for all soil remediation, soil undercuts, and foundation removal.
b. Clearly delineate the perimeter, corners, and elevations of all locations in which foundations were removed and where authorized undercut areas were excavated.
c. Survey to include spot elevations along perimeter and corners of the property lines/project boundary lines.
d. Provide dimensions from property lines to benchmarks and to all undercut areas and excavation areas.
e. Provide length and width dimensions for all undercut areas and excavation areas.
f. Submit one (1) electronic copy in PDF format and three (3) full size hard copies, stamped by a Professional Land Surveyor, within 7 business days of completion of all demolition / excavation / export operations.
g. For projects with construction durations greater than 30 calendar days, submit one (1) electronic copy in PDF format monthly from construction start date to Preliminary Acceptance

## PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. All imported soil material must comply with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil."

B. All Materials: Comply with other Division 31 Sections.

C. General Fill: Provide soil materials conforming to ASTM D2487 soil groups GW, GR, GM, SW, SP or SM or a combination that are free of debris, waste, frozen materials, vegetable, organic and other deleterious matter and having maximum particle size of 2" in all dimensions. In addition to ASTM requirements, general fill shall not exceed the APPENDIX B, SECTION 742, TABLE A; TIERED APPROACH TO CORRECTIVE ACTION OBJECTIVES (TACO); 35 ILL ADM CODE 742 values for 35 ILL. ADM CODE 740 APPENDIX A Target Compound List (TCL) parameters

Select Fill: Clean natural or crushed stone or gravel conforming to State of Illinois, Department of Transportation Gradation CA 6. In addition to State of Illinois Depart of Transportation Gradation requirements, select fill shall not exceed APPENDIX B; SECTION 742, TABLE A;TIERED APPROACH TO CORRECTIVE ACTION OBJECTIVES (TACO); 35 ILL ADM CODE 742 values for 35 ILL. ADM CODE 740 APPENDIX A Target Compound List (TCL) parameters Underbed Material: Naturally or artificially graded mixture of natural or crushed stone or gravel conforming to State of Illinois, Department of Transportation Specifications for Gradation CA 8, CA 7, or as otherwise noted in plans

D. Underbed Material: Naturally or artificially graded mixture of natural or crushed stone or gravel conforming to State of Illinois, Department of Transportation Specifications for Gradation CA 8, or CA 7. In addition to State of Illinois Department of Transportation Specifications, Underbed material shall not exceed APPENDIX B; SECTION 742, TABLE A; TIERED APPROACH TO CORRECTIVE ACTION OBJECTIVES (TACO); 35 IL ADM CODE 742 values for 35 ILL. ADM CODE 740 APPENDIX A Target Compound List (TCL) parameters.

E. Use Contractor supplied off-site material except that general fill may be from excavation if found acceptable by the CHA**'s** testing agency. Material can be used provided that all off-site and general fill material does not exceed APPENDIX B; SECTION 742, TABLE A; TIERED APPROACH TO CORRECTIVE ACTION OBJECTIVES (TACO): 35 ILL ADM CODE 7D42 values for 35 ILL. ADM CODE 740 APPENDIX A Target Compound List (TCL) parameters. Provide all materials required to complete the Work in the Contract.

F. Field/Paver Base: Contractor's option if monolithic (one fill throughout) or multiple course construction is employed, subject to review and written approval by the surfacing system manufacturer. Course material shall comply with the following:

1. Field Base Fill: Clean natural, crushed, or fractured stone conforming to the following gradation: CA7/CA-1
2. Field Surface Fill: Clean natural, crushed, or fractured stone conforming to the following gradation: McCook 210 or CA-16.

G. Geotextile Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf; ASTM D4632/D4632M.
3. Sewn Seam Strength: 142 lbf; ASTM D4632/D4632M.
4. Tear Strength: 56 lbf; ASTM D4533/D4533M.
5. Puncture Strength: 56 lbf; ASTM D4833/D4833M.
6. Apparent Opening Size: No. 70 sieve, maximum; ASTM D4751.
7. Permittivity: 0.5 per second, minimum; ASTM D4491/D4491M.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355/D4355M.

2.2 SOURCE QUALITY CONTROL

A. See Section 01 40 00 "Quality Requirements", for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, testing of samples for compliance will be provided before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that survey benchmark and intended elevations for the Work are as indicated.

B. Verify the absence of standing or ponding water.

C. Verify subdrainage, damp proofing, or waterproofing installation has been inspected

D. Verify areas to be filled are not compromised with surface or groundwater.

## 3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.

D. Protect utilities that remain and protect from damage.

## 3.3 TEMPORARY EROSION CONTROL

A. Before mobilizing and starting Work on the site, institute, expand as necessary, and maintain throughout the project a sediment and erosion control system that complies with EPA 832/R-92-005 and as required by authorities having jurisdiction, City of Chicago.

B. Control erosion and sediment damage to roadways, adjacent properties, and water resources using basins, ditch checks, temporary ditches, mulch barriers, mulches, grasses, silt filter fences, hay or straw bales, aggregate barriers, inlet and pipe protection and other appropriate means.

## 3.4 CLEARING

A. General:

1. Environmental Hazards: Before starting Work and thereafter as appropriate, report conditions indicative of environmental hazards to the CHA's Designated Representative and proceed as directed.
2. Remove vegetation, improvements, or obstructions that interfere with installation of new construction. Removal includes new and old stumps and their roots.
3. Carefully and cleanly cut roots and branches of vegetation to be left standing, where such roots and branches obstruct new construction.
4. Comply with the environmental protection and safety requirements of all authorities having jurisdiction. Keep dust to a minimum. Maintain streets free of mud, dirt and debris.
5. Refer to Section 31 10 00 "Site Clearing" for additional clearing requirements.

B. Removal of Improvements:

1. Remove improvements that interfere with construction.
2. Cap and remove abandoned underground piping or conduit.
3. Where uncharted or incorrectly charted below grade improvements are discovered, obtain approval of Architect before removal.

## 3.5 EXCAVATION

A. General:

1. Excavation consists of the removal and disposal of materials encountered when establishing the required grade elevations. Such excavation is unclassified regardless of the materials
2. Unauthorized excavation consists of removal of materials beyond indicated or required elevations. Replace unauthorized excavation by backfilling and compacting as specified for select fill at no cost to CHA.
3. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect.
4. Do not remove topsoil when wet
5. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.
6. Excavate under Building to the extent required to establish subgrades.
7. Excavate under pavements as required to comply with cross sections, elevations and grades.
8. Excavate elsewhere as required to establish new finish grades, allowing not less than 12 inches for topsoiling.
9. When excavating through roots, perform work by hand and cut roots with sharp axe.

B. Dewatering:

1. Prior to commencing work, the Contractor shall provide a storm water management plan. This plan shall stipulate provisions for dewatering, pumping, collection, temporary storage, and discharge or disposal of storm water, perched water and other liquids, contaminated and/or uncontaminated, at the site so as to facilitate soil removal and minimize disposal costs for contaminated fluids.
2. Do not allow water to accumulate in excavations. Remove water from excavations to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey the water away from the site.
3. Convey water removed from excavations and rainwater to collecting or run-off areas acceptable to authorities having jurisdiction. Do not use trench excavations for site utilities as temporary drainage ditches.
4. Comply with requirements of authorities having jurisdiction, including but not limited to, the City of Chicago and the Metropolitan Water Reclamation District of Greater Chicago.

C. Stability of Excavations:

1. Slope the side of excavations to comply with local codes, authorities having jurisdiction, and the City of Chicago, and maintain same. Secure, shore, and brace where sloping is not possible either because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

D. Shoring and Bracing:

1. Provide shoring and bracing to comply with local codes, authorities having jurisdiction and the City of Chicago.
2. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable conditions.

3. Maintain shoring and bracing in excavations regardless of the time period excavations will be open. Carry down shoring and bracing as the excavation progresses.

E. Material Storage:

Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust

a. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

F. Excavation for Structures:

1. Excavate to the subgrade elevations required within a tolerance of plus or minus 0.10' to balance, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction required, and for inspection.
2. Take care not to disturb the bottom of the excavation. Excavate by hand to final grade just before concrete is placed. Trim bottoms to the required lines and grades to leave a solid base to receive concrete.

G. Excavation for Pavements: Cut the surface under pavements to comply with cross sections, elevations, and grades.

H. Removal of Unsatisfactory Soil Materials:

1. Excavate unsatisfactory soil materials encountered that extend below the required elevations, to the additional depth established by the Contractor's testing service and approved by CHA.
2. Such additional excavation, provided it is not due to the fault or neglect of the Contractor, will be measured and paid for as a change in the Work if approved by CHA.

I. Closing Abandoned Underground Utilities: Close open ends of abandoned underground utilities, which are to remain permanently, and with sufficiently strong closures to withstand pressures which may result after closing.

J. Cold Weather Protection: Protect excavation bottoms against freezing when the atmospheric temperature is less than 35 degrees F. Maintain excavation free of water, ice, and snow.

## 3.6 PROOF ROLLING

A. Proof Roll entire area under building and pavements with a pneumatic roller or heavily loaded dump truck (minimum 25 tons).

B. Make at least two (2) passes (second at right angle to first) in the presence of a representative of the Contractor's testing service.

C. Excavate unsatisfactory soil materials encountered to the additional depth established by the Contractor's testing service and in accordance with geotechnical investigation report. All undercuts must be approved by CHA.

D. Perform no further Work until slab subgrades are acceptable to the representative of the Contractor's testing service.

## 3.7 COMPACTION

A. General: Control soil compaction during construction, providing the minimum percentage of density specified.

B. Percentage of Maximum Density Requirements: Provide not less than the following percentages of density of soil material compacted at + 2% optimum moisture content, for the actual density of each layer of soil material-in-place:

1. Compact top 12" of subgrade and each layer of backfill or fill material to 75% relative density for cohesionless soils (ASTM D 4253 & D 4254) and 95% maximum density for cohesive soil (ASTM D 1557).

C. Moisture Control:

1. Where the subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to the surface of subgrade, or layer of soil material, to prevent free water appearing on the surface during or subsequent to compaction operations.
2. Remove and replace, to scarify and air dry, soil material that is too wet to permit compaction to specified density.

## 3.8 BACKFILL AND FILL

A. Prior to Backfill Placement: Backfill excavations as promptly as the Work permits, but not until completion of the following:

1. Review of construction below finish grade.
2. Code required inspection, testing, approval, and recording locations of underground utilities.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
5. Removal of trash and debris.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

B. Ground Surface Preparation:

1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material bonds with existing surface.

2. When the existing ground surface has a density less than that specified under "Compaction" for the particular area classification, break up the ground surface, pulverize, bring moisture condition to the optimum moisture content, and compact to the required depth and percentage of maximum density.
3. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

C. Placement and Compaction:

1. Place backfill and fill materials to required grades in layers not more than 8" in loose depth for materials compacted by heavy compaction equipment and not more than 4" in loose depth for materials compacted by hand operated tampers. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the soil material. Compact each layer to the required percentage of density.
2. Place backfill and fill materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
3. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
4. Backfill and fill under Building slabs to an elevation required to allow for thickness of underbed shown or a minimum of 6" if not shown. See structural drawings and geotechnical report for fill requirements under building slabs.
5. Backfill and fill under pavements as required to comply with cross sections, elevations and grades shown.
6. Fill and backfill under footings where not on undisturbed ground using select fill material.
7. Backfill and fill elsewhere as required to establish new finished grades, allowing not less than 12 inches for topsoiling using select fill.

D. Under Bed: Place and compact underbed material under all slabs-on-grade.

E. Slope grade away from building minimum 2 inches in 10 feet, unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

F. Reshape and re-compact fills subjected to vehicular traffic.

G. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Architect/Engineer of Record. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

## 3.9 GRADING

A. General: Verify all building and trench backfilling have been inspected. Uniformly grade the area, including adjacent transition areas. Smooth finished surfaces within specified tolerances, compact with uniform levels or slopes between elevation points, or between such points and existing grades. Verify all subgrades have been contoured and compacted.

B. Grassed Areas: Finish areas to receive topsoil to within not more than 0.10' above or below the required subgrade elevations, compacted as specified, and free from irregular surface changes.

C. Walks: Shape the surface of areas under walks to line, grade, and cross section, with the finish surface not more than 0.00' above or 0.10' below the required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains.

D. Pavements: Shape the surface of the areas under pavement to line, grade and cross section, with the finish surface not more than 1/4" above or below the required subgrade elevation, compacted as specified, and graded to prevent ponding of water after rains.

## 3.10 FIELD QUALITY CONTROL

A. See Section 01 40 00 “Quality Requirements”, for general requirements for field inspection and testing.

B. Quality Control Testing During Construction:

1. The Contractor’s testing service must inspect and approve sub-grades and fill layers before further construction work is performed thereon.
2. If, in the opinion of the Contractor’s testing service, based on reports of the testing service and inspection, the subgrade or fills which have been placed are below the specified density, additional compaction and testing shall be required until satisfactory results are obtained at no additional cost to CHA. In such event, retesting shall be paid by the Contractor.

C. The Contractor will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during earthwork operations.

D. Contractor’s Responsibilities

1. Notify Agency sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.
2. Coordinate with Agencies’ personnel; provide access to Work, to manufacturer’s operations.
3. Provide preliminary representative samples of materials to be tested, in required quantities.
4. Furnish casual labor and facilities to provide access to Work to be tested to obtain and handle samples at the site to facilitate inspections and tests, and storage and curing of tests.
5. Arrange with laboratory, pay for, additional samples and tests required when initial tests indicate Work does not comply with Contract Documents.

E. Tests for Proposed Soil Materials:

1. Test soil materials proposed for use in the Work and promptly submit test result reports. Soil samples shall be provided by Contractor.
2. Provide one optimum moisture-maximum density curve for each type of cohesive soil. Determine maximum densities in accordance with ASTM D 1557.
3. Determine the suitability of materials to be used as fill and backfill.
4. Perform a mechanical analysis (AASHO T88), plasticity index (AASHO T91), and frost susceptibility analysis.
5. Supply only soil materials that comply with Section 31 23 23 "Acceptance of Backfill, Top Soil, & CU Structural Soil.”

F. Verification of Footing Subgrades:

1. Provide one optimum moisture-maximum density curve for each type of soil encountered.
2. For each strata of soil on which footings are to be placed, conduct at least one test to verify the required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with the related tested strata.

G. Compaction Testing:

1. Inspect, test, and approve each lift of fill and backfill before next lift is placed. Test in accordance with ASTM D1556 or ASTM D2167 as appropriate.
2. Field density tests may be performed by the nuclear method in accordance with ASTM D 6938. The calibration curves shall be periodically checked and adjusted to correlate to tests performed using ASTM D1556 or ASTM D2167. Calibration of nuclear density testing device shall be in accordance with ASTM D7759.
3. If field tests are performed using nuclear methods, the inspection and testing agency shall make calibration checks on both density and moisture gauges at beginning of work, on each different type of material encountered, and at intervals as specified by the equipment manufacturer.
4. Take a field density test for each 2,000 sq. ft. of backfill and fill under slabs and pavements.
5. Take a field density test at 100 foot intervals along the inside of continuous footings, but not less than one (1) test per 20 foot run.
6. Take a field density test for each four (4) isolated footings.
7. Take a field density test at 50 foot intervals along utility trench backfill under slabs and pavements.

H. Proof rolling Observation:

1. Provide continuous observation of proof rolling of entire building, parking lot, track surface, and artificial turf areas. Four passes shall be made.
2. If testing agency representative determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
3. Authorized additional excavation, beyond what is specified in the contact documents, and replacement material will be paid for according to Contract provisions for changes in the Work.
4. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.
5. Approve subgrade or make recommendations for removal.
6. If undercuts or over excavation are required. Submit scaled plan showing all areas of undercuts and depths of each cut for engineer and CHA approval.

I. Submittals: Submit copies of the following reports:

1. Report and certification of granular fill and drainage fill.
2. Test reports on fill and backfill material.
3. Verification of each footing subgrade.
4. Field density test reports.
5. One optimum moisture-maximum density curve for each type of soil encountered.
6. Report of actual unconfined compressive strength and/or results of plate bearing tests of each strata tested.

7. Other tests' and materials' certificates, as required.

3.11 MAINTENANCE AND RESTORATION

A. Protection of Graded Areas:

1. Protect newly graded areas from traffic and erosion, and keep free of trash and debris and growth of weeds.
2. Repair and reestablish grades in settled, eroded, and rutted areas to the specified tolerances.

B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather scarifies the surface, reshape, and compact to the required density prior to further construction.

C. Restoration: Restore all areas affected by construction both on and off CHA's property to original condition.

3.12 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Burning is not permitted on the CHA's property.

B. All surplus excavation, waste materials, and demolition debris shall be removed and disposed of off-site at a licensed landfill, recycling center, reused on site, or otherwise disposed of in accordance with local, state, and federal disposal laws and regulations, including the Illinois Environmental Protection Agency's (IEPA), and Section 31 23 18.13 "Subtitle D Waste Disposal", "Section 31 23 18.14 "Clean Construction of Demolition Debris and Uncontaminated Soil", 31 23 18.15 "Special, Non-Hazardous Special, and Hazardous Waste Soil Removal and Disposal" and/or Section 01 74 19 "Construction Waste Management and Disposal," as applicable.

**END OF SECTION**

# SECTION 31 23 17

# EXCAVATING, BACKFILLING, AND COMPACTING FOR UTILITIES

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes the following:

1. Excavation for trenches for water, sanitary sewer, site drainage, and storm sewer lines to public utility.
2. Compacted bed and compacted fill over utilities to subgrade elevations.
3. Compaction.

B. Related Requirements:

1. Section 31 10 00 “Site Clearing”.
2. Section 31 22 14 “Earthwork”.
3. Section 31 23 18.13 “Subtitle D Waste Disposal”.
4. Section 31 23 18.14 “Clean Construction of Demolition Debris and Uncontaminated Soil”.
5. Section 31 23 23 “Acceptance of Backfill, Top Soil, & CU Structural Soil”.

### 1.3 SUBMITTALS

A. Submit 10 lb samples of each material to be used. Identify source, type (use) of each material and gradation. Forward to Contractor’s testing agency packed tightly in containers to prevent contamination. Submit copy of transmittal to Architect.

### 1.4 QUALITY ASSURANCE

A. Tests and analysis of fill materials will be performed in accord with ASTM D1557, and with General Conditions and testing required by other Division 31 Sections for acceptability as fill material.

### 1.5 PROTECTION

A. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods or prevent cave-in or loose soil from falling into excavation.

B. Underpin adjacent structures which may be damaged by excavation work, including service utilities and pipe chases.

C. Notify Architect immediately of unexpected subsurface conditions. Confirm notification in writing. Discontinue work until Architect issues written notification to resume work.

D. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.

E. Grade excavation tip perimeter to prevent surface water runoff into excavation.

## PART 2 - PRODUCTS

2.1 MATERIALS

A. Granular Fill Type A:

1. Material for granular fill shall be FA-6 in compliance with IDOT SSRBC 2016, Article 1003. The material shall be graded from coarse to fine and shall conform to the following gradations:

a.

| Sieve Size | Percent Passing |
|---|---|
| No. 4 | 84-100 |
| No. 100 | 0-40 |
| No. 200 | 0-12 |

2. Bedding Material: Material for bedding shall be CA-11 in compliance with IDOT 2016, Article 1004 and shall conform to the following gradations:

a.

| Sieve Size | Percent Passing |
|---|---|
| 1 inch | 100 |
| 3/4 inch | 84-100 |
| 1/2 inch | 30-60 |

B. Fill Material Type D: Fill material shall be cohesive soil obtained from off-site required excavations and approved by the Contractor's testing agency representative as suitable backfill material in accordance with ASTM D 2487, Uniform Soils Classification System 1 and 703.5. It shall be used to backfill excavations where the excavated material is unsuitable for backfill.

C. Fill Material Type E: Fill under landscaped areas shall be free from alkali, salt shall not exceed Appendix B, Section 742, Table A This fill shall be approved by the Contractor's testing agency representative.

D. Fill Material Type X: Off-site borrow material shall comply to soil types GP, GW, SC, and CL in accordance with ASTM D 2487. It shall be used where needed under structural slabs, roads, pavement, and landscaped areas.

E. All imported backfill material shall comply with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil."

## PART 3 - EXECUTION

### 3.1 INSPECTION

A. Verify stockpiled fill to be reused as approved in writing by Architect.

B. Verify foundation perimeter drainage installation has been inspected and approved in writing by Architect.

C. Verify and confirm in writing that areas to be backfilled are free of debris, snow, ice or water, and surfaces are not frozen.

### 3.2 PREPARATION

A. Identify specified lines, levels, contours, and data.

B. Compact subgrade surfaces to density specified for backfill materials.

### 3.3 EXCAVATION

A. Cut trenches wide enough to enable utility installation and allow inspection.

B. Hand trim excavation and leave free of loose matter. Hand trim for bell and spigot pipe joints.

C. Excavation shall not interfere with normal 45 degree bearing splay of foundations.

D. Sides, walls, or faces of all trenches shall be sloped and maintained in a safe manner and in the required condition until completion of backfilling. Excavations shall be braced or sloped in compliance to the latest Occupational Safety and Health Administration (OSHA) requirements or as instructed by the testing agency on-site representative.

E. Locate and retain reusable excavated materials away from the edge of excavation.

### 3.4 BACKFILLING

A. Support pipes, and conduits during placement and compaction of bedding fill.

B. Backfill trenches to contours and elevations shown. Backfill systematically, as early as possible to allow maximum time for natural settlement. Do not backfill over porous, wet, or spongy subgrade surfaces.

C. Place compact fill materials in continuous layers as specified in Division 31 Section "Earthwork."

D. Use a placement method that will not disturb or damage utilities in trenches, perimeter drainage.

E. Maintain optimum moisture content of backfill materials, determined by laboratory analysis, to obtain specified compaction density.

## 3.5 FILL TYPES AND COMPACTION

A. Compact all fill and backfill to specified values based on Modified Proctor Test in accordance with Division 31 Section "Earthwork."

## 3.6 QUALITY CONTROL

A. Quality Control Testing During Construction: An independent inspection and testing agency employed by the Contactor shall inspect and approve each subgrade and fill layer before further backfill and fill work is performed. All imported soil material must comply with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil."

1. The inspection and testing agency shall perform laboratory density tests in accordance with ASTM D 1557.
2. Field density tests shall be in accordance with ASTM D1556 or ASTM D2167 as appropriate.
3. Field density tests may be performed by the nuclear method in accordance with ASTM D 6938. The calibration curves shall be periodically checked and adjusted to correlate to tests performed using ASTM D 1556. Calibration of nuclear density testing device shall be in accordance with ASTM D7759.
4. If field tests are performed using nuclear methods, the inspection and testing agency shall make calibration checks on both density and moisture gauges at beginning of work, on each different type of material encountered, and at intervals as specified by the equipment manufacturer.
5. If, in the opinion of the Contractor's testing agency representative, based on the inspection and testing agency reports and inspections, subgrade or fills have not been placed to specified density, the Contractor shall perform additional compaction and retesting until specified density has been achieved. The Ccontractor shall pay for all retesting work.
6. The Contractor shall assist the inspection and testing agency by providing access to the excavation and fill areas, and by removing loose materials from compacted soil layers prior to testing.

## 3.7 REMOVAL AND DISPOSAL

A. Remove surplus backfill materials and materials unsuitable for backfill from the site in compliance will Specifications including Section 31 23 18.13 "Subtitle D Waste Disposal", Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," or Section 31 23 18.15 "Special, Non-Hazardous Special, and Hazardous Waste Soil Removal and Disposal", as applicable.

**END OF SECTION**

**SECTION 31 23 18.13**

**SUBTITLE D WASTE DISPOSAL**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings

1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects where materials existing on the site that will be removed. This specification section applies to Subtitle D Waste that does not meet the definition of the Clean Construction or Demolition Debris (CCDD), Uncontaminated Soil or Hazardous Waste.

1.3 INTRODUCTION

A. Description of Work: This specification is for the excavation, stockpiling, loading, hauling, removal, and disposal of Subtitle D Waste which includes soils, fill, backfill, topsoil, CU Structural Soil, and general construction and demolition debris from CHA projects. The locations of Subtitle D Waste on the project site shall be determined by the CHA, in consultation with the Environmental Consultant (EC), and are initially identified in the Contract Documents. The Contractor shall perform the work under this section in accordance with all applicable local, county, IEPA, USEPA, and OSHA regulations. The Work shall include the following:

1. Removal and disposal
    a. Prior to excavation of any Subtitle D Waste, obtain authorization for ultimate disposition of materials from an open and active Subtitle D facility approved by the CHA's Designated Representative and EC. The Subtitle D facility shall be permitted to accept both Non-Hazardous Special Waste and Special Waste.
    b. The waste characterization analytical must be sent to the EC for approval and to the CHA's Designated Representative for signature prior to sending the profile to the landfill. Contractor shall allow 5 working days to receive authorized signature from CHA's Designated Representative.
    c. Perform the analytical testing required by the landfill for waste stream authorizations as necessary to secure all required disposal permits for all materials. All costs associated with collecting waste stream samples and performing analytical tests shall be at Contractor's own expense.
    d. Obtain authorization from an open and active Permitted Subtitle D landfill indicating acceptance of materials at the facility. The Authorization must be signed by the owner of the open and active Permitted Subtitle D landfill and state that the facility complies with all local zoning codes and all local, state, and federal rules and regulations, that all required laboratory analyses has been received by the facility, and that the facility has agreed to accept the waste materials. The Authorization shall further state that the waste materials are being accepted for permanent

placement on site under the cap, and that the waste material will not be removed from the site unless required by a local, state, or federal regulations.

e. Prepare daily reports, transport manifests, weight tickets and receipts (as applicable) prior to starting any soil removal activities.

f. Excavation of Subtitle D Waste to the depth required to complete the proposed site preparation/construction work activities as specified in the Contract Documents.

g. Load and transport all materials to the approved open and active Permitted Subtitle D landfill into approved containers or vessels.

h. Provide copies of all daily reports, signed transport/waste manifest, signed weight tickets, and disposal receipts (as applicable) to the CHA's Designated Representative and EC daily documenting proper disposal of the waste materials.

i. Decontaminate areas where contaminated soil or contaminated liquid wastes were spilled. Containerize decontamination residuals for final disposition.

1.4 DEFINITIONS

A. Agency means Illinois Environmental Protection Agency (IEPA).

B. Backfill means granular or cohesive material used to fill the excavation to design grade as referenced in design plans and specifications.

C. CFR means Code of Federal Regulations

D. Chicago Housing Authority (CHA) means the owner of the property and the authority ordering the work specified herein.

E. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

F. Clean Construction or Demolition Debris (CCDD) means any of the following materials, alone or in combination, that (i) have been generated from construction or demolition activities and (ii) are *uncontaminated*:

broken concrete without protruding metal bars,
bricks,
rock,
stone,
reclaimed or other asphalt pavement

Uncontaminated soil which is comingled with any of the above materials is also considered CCDD. [415 ILCS 5/3.160(b)]

G. CU Structural Soil means a uniformly blended mixture of crushed stone, clay, loam, and hydrogel by weight consisting of approximately 83% crushed limestone (3/4 to 1.5 inch, highly angular with limited fines), 17% clay loam and hydrogel (1 oz. per 200 pounds of stone).

H. Discharge Authorization (DA) is a written authorization issued by the MWRDGC giving permission to discharge wastewaters to its sewer system and sewage treatment facilities.

I. DOT means Department of Transportation.

J. Environmental Consultant (EC): The entity with overall responsibility for the environmental program, including design, organization, monitoring and development of the environmental program which includes investigations, assessments, designs, and supervision of remediation work.

K. Fill means any earthen or non-earthen materials including but not limited to any sediment, granular or cohesive non-native earthen materials, cinders, ash, wood, and brick, concrete, and asphalt fragments, glass, and building debris encountered above naturally occurring undisturbed soils or bedrock in built-up areas.

L. General Construction and Demolition (C&D) Debris means non-hazardous, uncontaminated materials resulting from construction, remodeling, repair, and demolition of utilities, structures, and roads as defined in Public Act 92-0574, the Environmental Protection Act, 415 ILCS 5 Section 3.160 and regulated under Title 35: Environmental Protection; Subtitle G: Waste Disposal; Chapter I: Pollution Control Board; Subchapter i: Solid Waste and Special Waste Hauling. General Construction and demolition (C&D) debris may include soil, wall coverings, reclaimed asphalt pavement, rock, plaster, glass, non-hazardous painted wood, drywall, plastics, non-hazardous coated wood, non-asbestos insulation, bricks, wood products, roofing shingles, concrete, and general roof coverings.

M. IDOT means Illinois Department of Transportation.

N. IEPA means Illinois Environmental Protection Agency.

O. Manifest means the form provided or prescribed by IEPA and used for identifying name, quality, routing, and destination of non-hazardous special waste during its transportation from point of generation to the point of disposal, treatment, or storage.

P. MWRDGC means the Metropolitan Water Reclamation District of Greater Chicago.

Q. Open and active Permitted Subtitle D landfill means any open and active solid waste landfill facility in any state licensed and permitted to accept non-hazardous waste including both non-special waste soils and non-hazardous special waste soils, fill, general construction, and demolition debris. If the landfill facility is in Illinois, the landfill must be licensed/ open, active, and permitted by the Illinois Environmental Protection Agency and other applicable local regulatory agencies as applicable. If the landfill is located outside of Illinois, the landfill facility must be open, active, and permitted by applicable state and local regulatory agencies.

R. OSHA means Occupational Safety and Health Administration.

S. Remediation Area means any area on site where underground storage tanks, non-special waste and/or non-hazardous special waste, or soil that does not meet most stringent Tier 1 SROs for residential properties is present.

T. SDS means Safety Data Sheet, required by OSHA for any substances that are toxic, caustic, or otherwise potentially hazardous to workers.

U. Soil means any granular or cohesive materials designated for removal as specified in the Architect drawings and specifications and includes soils that are determined to be non-special and special waste.

V. Special Waste means any wastes as defined in Title 35: Environmental Protection; Subtitle G: Waste Disposal; Chapter I: Pollution Control Board; Subchapter i: Solid Waste and Special Waste Hauling; Part 808: Special Waste Classifications; Subpart A: General Provisions; Section 808.110,

AND

Any wastes as defined in Title 35: Environmental Protection; Subtitle G: Waste Disposal; Chapter I: Pollution Control Board; Subchapter i: Solid Waste and Special Waste Hauling; Part 809: Non-Hazardous Special Waste Classifications; Subpart A: General Provisions; Section 809.103.

W. SROs mean Soil Remediation Objectives for various exposure routes identified in 35 Illinois Administrative Code 742: Tiered Approach to Corrective Action Objectives (TACO).

X. Storm water means water deposited at the site in the form of rain, snow, or other natural weather event.

Y. Subtitle D Waste means any soils (including non-special waste soils and non-hazardous special waste soils), fill, backfill, topsoil, CU Structural Soil, and general construction and demolition debris that permitted to be deposited into a Subtitle D landfill. Subtitle D Wastes do NOT meet the definition of Clean Construction or Demolition Debris or Uncontaminated Soil as defined in Section 3.160 of the Environmental Protection Act, TSCA Waste, or Hazardous Wastes.

Z. TACO means TIERED APPROACH TO CORRECTIVE ACTION OBJECTIVES (TACO) per 35 Illinois Administrative Code 742.

AA. Topsoil means soils placed to design grade and used to promote vegetative growth and which meets Topsoil criteria (percentages of organic matter, inorganic matter (silt, clay, and sand)), deleterious material, pH, and mineral and plant-nutrient content as referenced in the contract specifications and drawings.

BB. Uncontaminated Soil means soil generated during construction, remodeling, repair or demolition of utilities, structures and roads that does not contain contaminants in concentrations that pose a threat to human health and safety and the environment. [415 ILCS 5/3.160(c)]

CC. USEPA means United States Environmental Protection Agency.

DD. User or User Agency means the entity for which or on whose behalf the CHA has undertaken to cause the Work to be performed.

EE. Work means the obligations of the Contractor under the Contract Documents. Work includes, unless specifically excepted by the Contract Documents, the furnishing of all materials, labor, equipment, and supplies for the full performance and completion of the requirements of the Contract Documents. Work also means that which is furnished, produced, constructed, or built pursuant to the Contract Documents.

## 1.5 SUBMITTALS

A. Copies of the following submittals shall be prepared and submitted to the CHA's Designated Representative and EC at Contractor's own cost and within ten (10) days prior to start of Work:

1. Contractor's Site-Specific Health and Safety Plan for all workers engaged in excavation, stockpiling, loading, hauling, removal, and disposal of any Subtitle D Wastes from the property. The plan shall comply with all OSHA requirements utilizing information obtained from existing environmental reports. The Work shall be performed under the direct supervision of a trained experienced site supervisor. The plan should at a minimum include the following:
    a. Contact information of key personnel and alternates responsible for site safety.
    b. Describe the risks associated with each operation conducted.
    c. Describe chemical contaminants to be encountered by employees on work site and specific hazards if any to the workers as required by OSHA.
    d. Type of personnel training and responsibilities and to handle the specific hazardous situations they may encounter.
    e. Describe the protective clothing and equipment to be worn by personnel during various site operations.
    f. Describe any site-specific medical surveillance requirements.
    g. Describe the program for the periodic air monitoring, personnel monitoring, and environmental sampling if needed.
    h. Describe the actions to be taken to mitigate existing hazards to make the work environment less hazardous.
    i. Define site control measures including a site map.
    j. Establish procedures for personnel and equipment and transporting trucks to ensure that impacted soils are not tracked off site on to non-impacted areas of the site.
    k. Set forth the site Standard Operating Procedures (SOPs). SOPs are those activities that can be standardized (i.e., decontamination procedures and respirator fit testing).
    l. Set forth a Contingency Plan for the safe and effective response to emergencies.
2. Soil Management Plan outlining proposed excavation work sequences and procedures to separate each type of material to be removed from the site from clean materials. The Soil Management Plan shall show the locations of each type of material to be stored on site, location of clean materials to be stored at the site for reuse, and location of material to be stored on site for future disposal. The EC and the CHA must review and approve this plan. The Soil Management Plan shall also include information regarding concrete and brick recycling procedures and name and address of the concrete and brick recycling sites that will be used as part of this project.

3. Disposal Facility Information - Name, address, and telephone number of the open and active permitted Subtitle D Landfill facility where Subtitle D Wastes are to be deposited. The Subtitle D facility shall be permitted to accept both Non-Hazardous Special Waste and Special Waste. This submittal must be made prior to removal of any materials from the site. This information should include, at a minimum, the following:

    a. Facility Name and Address and Telephone Number.
    b. Facility Contact.
    c. Facility Identification Number issued by Illinois, U.S. EPA, or other state licensing agencies for Special Waste Disposal facility.
    d. U.S. EPA Treatment/Disposal Site ID numbers (for liquid waste only).
    e. State and/or Local Operational Permit Number(s) for the impacted Construction and Demolition Debris Disposal sites.

4. The Contractor shall fill out the waste profile, including the waste characterization laboratory results from analytical testing laboratory accredited in accordance with the

Illinois Administrative Code, Title 35, Subtitle A Chapter II, Part 186, for the landfill and send it to the EC for approval. The EC will forward the waste profile to the CHA for signature. The Contractor shall assume this signature process will take five (5) business days to accomplish.

5. Waste Stream authorization and/or permit from the Subtitle D Landfill facility where Subtitle D Wastes are to be deposited prior to removal from the site. The authorization must be signed by the Subtitle D landfill facility representative and state that the facility complies with all local zoning codes and all local, State, and Federal rules and regulations, that all required laboratory analyses has been received by the facility, and that the facility has agreed to accept the waste materials. The Authorization shall further state that the wastes materials are being accepted for permanent placement on site, and that the waste material will not be removed from the site unless required by a local, state, or federal Authority.

6. Operating licenses for Special Waste transporter(s), as applicable. Details of haul routes from site to the disposal/treatment facilities.

7. Air sampling data collected during the Work, including OSHA compliance air monitoring.

8. Decontamination Plan outlining the decontamination procedures for equipment and vehicles utilized to excavate and remove Subtitle D Wastes from CHA property.

9. Ten (10) days prior to commencing Work, the Contractor shall provide the EC a Storm Water Management Plan and MWRDGC permit schedule. This plan shall stipulate provisions for dewatering, pumping, collection, temporary storage, and discharge or disposal of storm water, perched water, and other liquids, contaminated and/or uncontaminated, at the site to facilitate water and soil removal as well as minimize disposal costs for contaminated fluids. Contractor shall manage and remove water from the excavation in accordance with the City of Chicago and MWRDGC's requirements. The Contractor shall not discharge onsite water into the sewer system without procuring all required permits. The EC and the CHA must review and approve this plan.

10. Copy of the pumping permit from the City of Chicago Building Department prior to pumping any water into the City of Chicago sewer system.

11. Copy of the MWRDGC Discharge Authorization prior to discharging any contaminated water into the City of Chicago sewer system.

12. Copies of Special Waste Hauler Licenses/Permits for each proposed transporter prior to removal of Subtitle D Waste that also meets definition of Special Waste from the site, pursuant to 35 IAC 809. Include current copy of IEPA and/or USEPA approval letter/permit, and details of haul route(s) from site to the disposal facilities.

13. Copies of Special Waste disposal manifests (as applicable), tracking receipts, and weight tickets to the EC daily. Manifests must be fully executed by the generator, transporter, and designated disposal facility. All applicable documents shall be presented in dated order with attached summary table and must be received by the CHA within ten (10) working days of off-site removal date(s).

14. Daily Reports/Logs summarizing excavation activities generating waste, locations of where the disposed materials derived, any temporary stockpile locations, transporter information, equipment, and labor. Contractor shall submit these records on monthly basis.

1.6 SUBMITTAL REVIEW

A. Review of submittals or any comments made does not relieve the Contractor from compliance with the requirements of the drawings and specifications. The purpose of this check is to review for general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for confirming and correlating all quantities and dimensions; electing techniques of construction; coordinating the Work; and performing the Work in a safe and satisfactory manner.

B. The Contractor must not begin any Work applicable to this section until all required submittals have been reviewed and accepted by the CHA's Designated Representative and EC.

1.7 NOTIFICATIONS

A. The Contractor shall notify the CHA's Designated Representative and EC no less than forty-eight (48) business hours prior to loading and transporting any materials from the site. No Subtitle D Wastes shall be removed from CHA sites unless EC is present. Soils removed from the site without presence of EC may be subject to retrieval by the Contractor at the request of CHA.

1.8 RECORDKEEPING

A. The Contractor shall provide documentation of labor, equipment, materials, tickets, manifests, and disposal laboratory analysis used for Subtitle D Waste removal, when requested by the CHA's Designated Representative or EC.

1.9 COORDINATION OF WORK

A. The Contractor shall coordinate and schedule the Work to cause the least possible disruption to the daily site activities, if any.

B. The Contractor shall cooperate with and coordinate work progress with the CHA's Designated Representative, the EC, and any other contractors working on site. Excavated material shall be stockpiled near the excavation or at an area deemed suitable by the CHA's Designated Representative. The Contractor shall assist the CHA's Designated Representative or EC with its machinery and operator to inspect and obtain soil or fill samples, if necessary, from the open excavation(s) at no additional cost to the project.

1.10 JOB CONDITIONS

A. The Contractor shall perform all Work without creating an unsafe or hazardous condition, nuisance, or hinderance to operating conditions anywhere on site.

B. All excavation, truck loading, grading, and backfilling operations will be conducted to ensure minimum interference with traffic. Roads, streets, walks, and other adjacent occupied and used facilities shall not be closed or obstructed without permission from the applicable governing agency and the User. Alternate routes around closed or obstructed traffic ways must be provided if required by the governing agency.

C. Any damage caused to adjacent pavement, utilities, or facilities by earth work operations will be promptly replaced or repaired at no additional cost to the CHA and such work shall be performed to the satisfaction of the CHA.

D. Contractor is responsible to maintain project site and adjacent areas and roadways in neat and orderly condition.

## PART 2 - PRODUCTS

2.1 REMOVAL OF SUBTITLE D WASTE

A. The Contractor shall furnish all necessary means, products, tools, and equipment required to remove Subtitle D Wastes from the site per Contract Documents.

B. The Contractor shall also furnish all necessary means, products, tools, and equipment required to fulfill the scope of work described in the contract specifications and drawings. The Contractor, by submitting a bid for the Work, represents itself as knowledgeable and an expert in the performance of the Work, and includes all things usually and customarily necessary to provide a complete and finished job, whether specifically mentioned or not.

C. The Contractor must have a complete plan for the entire process of Subtitle D Waste removal and disposal in accordance with the project requirements. Contractor must provide schedule of all Work activities in accordance with the approved construction schedule.

## PART 3 - EXECUTION

3.1 AUTHORIZATIONS

A. Obtain authorization from the open and active Permitted Subtitle D landfill owner where Subtitle D Wastes are to be deposited. The Authorization must be signed by the Permitted Subtitle D landfill and shall state that the landfill has received a copy of one or more laboratory analyses of representative sample(s) collected from the site by the Contractor and has agreed to accept the material. The Authorization shall further state that the landfill agrees to accept the material for permanent placement on their site and that the material will not be removed from their site unless required by a local, state, or federal rules and regulations. The Authorization further shall state that the site complies with all local zoning codes, and local, state, and federal laws, rules, and regulations.

B. Obtain prior authorization from CHA's Designated Representative and EC to backfill excavations and utility lines and apply topsoil. All backfill, CU Structural Soil, and topsoil shall comply with Specification Section 31 23 23 Acceptance of Backfill, Topsoil, and CU Structural Soil in addition

to Section 31 22 14 "Earthwork" and Section 31 23 17 "Excavating, Backfilling, and Compacting for Utilities".

C. Haulers for transportation shall hold a current, valid hauling permit for materials being transported off-site. Haulers shall hold, and present upon request, a current valid Commercial Driver's License (CDL). Non-hazardous special wastes must be hauled by an IDOT-approved, licensed, and permitted transporter and must be valid during transportation.

D. Obtain prior authorization from CHA's Designated Representative on the Waste Profile at least (5) days in advance of removing waste materials.

## 3.2 MATERIAL SAMPLING

A. Subtitle D Waste Materials

1. The Contractor is responsible to notify the EC at least 48 hours prior to any waste characterization sampling activities.
2. The Contractor shall collect enough representative sample(s) from each type of material being removed from the site for analytical testing to obtain authorization for the ultimate disposition of the materials. The Contractor is responsible to provide the proper collection, handling, and transportation of the samples to the laboratory. The Contractor is responsible for acquisition of any required permits and payment of all fees.
3. The Contractor shall be responsible for obtaining liquid samples as needed for characterization for liquid disposal offsite or disposition onsite as applicable. The Contractor is responsible to the acquisition of any required disposal permits and the payment of any fees associated with liquid disposal.
4. The Contractor shall submit the solid and liquid samples (as applicable) to the laboratory and pay for the cost of analyzing the constituents required for the ultimate disposition of solids and liquids.
5. The EC may collect samples for laboratory analysis or field Photo-ionization Detector (PID) screening, or liquid samples for laboratory analysis (only if required by the CHA under special circumstance.) The Contractor shall provide the necessary equipment and manpower to assist the EC to collect materials to be sampled at no additional cost to the project.
6. The Contractor shall immediately notify the CHA's Designated Representative and EC if any materials, (solid or liquid) requiring special handling (i.e., stained soil, soil with odors, or liquids) are encountered in areas other than those identified in the contract drawings and referenced documents. No further work shall proceed in the area until approval is provided by the CHA's Designated Representative and EC.
7. All excavated soils, liquids, and other material shall be removed from the site in accordance with applicable specifications, and local, state, and federal requirements and guidelines.

## 3.3 EXCAVATION

A. Prior to starting any excavation work at the site, the Contractor shall layout site to designate remediation areas and or areas with different disposal classifications.

B. The Contractor shall perform excavation to the extent shown on the contract drawings, as necessary to complete the Work and/or as directed by the CHA's Designated Representative.

C. All excavation shall be performed in accordance with the design drawings and local, state, and federal requirements and guidelines.

D. The Contractor shall coordinate all Subtitle D Waste removal from the site activities with the EC. The Contractor must provide a written notification to the EC and CHA's Designated Representative at least 48-hour prior to starting any excavation or removal activity from the site.

E. Areas of the site may be classified differently in the Contract Documents. The Contractor shall be responsible for the removal of each type of material separately. The Contractor shall decontaminate all excavation equipment prior to excavating different classifications of materials generated onsite.

F. All excavation, truck loading, grading, and backfilling operations will be conducted to ensure minimum interference with traffic. Roads, streets, walks, and other adjacent occupied and used facilities shall not be closed or obstructed without permission from the applicable governing agency and the CHA's Designated Representative. Alternate routes around closed or obstructed traffic ways must be provided if required by the governing agency.

G. Secure, shore, and brace where sloping is not possible either because of space restrictions or stability of material excavated. Excavations shall be braced or sloped in compliance to the latest Occupational Safety and Health Administration (OSHA) requirements and shall comply with local codes, authorities having jurisdiction, and the City of Chicago, and maintain same. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable conditions. Maintain shoring and bracing in excavations regardless of the time excavations will remain open. Carry down shoring and bracing as the excavation progresses.

H. In the event the Contractor causes contaminated materials to be discharged onto or meet site surface materials including but not limited to soils; asphalt, concrete, bricks, and gravel, and the surface cannot be decontaminated, the surface materials shall be considered contaminated. The Contractor shall submit the sample(s) to the laboratory and pay for the cost of analyzing the constituents required for the ultimate disposition of such materials.

I. Any damage caused to adjacent pavement, utilities, or facilities by earth work operations will be promptly replaced or repaired at no additional cost to the CHA and such work shall be performed to the satisfaction of the CHA's Designated Representative.

J. The Contractor is responsible for keeping the soils/materials which are classified differently separated during excavation activities. If Contractor commingles soils/materials, the Contractor must properly dispose of all commingled soils/materials at their own expense.

K. If an underground storage tank (UST), drum or other unknown container is discovered during excavation activities, the Contractor must stop excavation work within 30 feet of the UST and immediately inform the CHA's Designated Representative, EC, and Site Superintendent. The CHA's Designated Representative will assess the site conditions and work with Site

Superintendent to control access to area and post appropriate signage. The CHA's Designated Representative, in consultation with EC, will instruct the Contractor how to proceed with the Work. Contractor may be asked by the CHA's Designated Representative or EC to perform further limited excavation in the area to gather information on size and/or quantity of newly discovered item(s). Contractor shall perform this limited excavation work at no additional cost to the CHA.

3.4 LOADING

A. The Contractor shall load Subtitle D Wastes directly from the site or from temporary stockpiles into hauling trucks for subsequent transportation and ultimate disposal.
B. Conduct all excavation, truck loading, grading, and backfilling operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities. Do not close or obstruct roads, streets or walks without permission from the applicable governing agency and the CHA. Alternate routes around closed or obstructed traffic ways must be provided by Contractor if required by the governing agency.
C. The Contractor shall maintain streets clean and free of mud, dust and dirt generated from their Work and operations.
D. The Contractor is responsible for complying with State and local road/street weight limits.

3.5 DECONTAMINATION & HAULING

A. The Contractor shall remove soils, dusts, rocks, etc. from the exterior of trucks, trailers, or other heavy equipment leaving the site before they leave the site.

B. The Contractor shall clean the tractor-trailers or trucks that are loaded with materials for off-site placement/salvage by removing clinging soils, or rocks from the exterior of the equipment.

C. The Contractor shall not create dust and shall maintain adequate dust suppression equipment on site if conditions warrant.

D. The Contractor shall maintain streets clean and free of mud, dust, and dirt. The Contractor shall provide a street sweeper for street maintenance, if requested by the CHA, at no additional cost to the project.

E. The Contractor shall conduct Subtitle D Waste removal in a manner that ensures minimum interference with roads; streets, walks and other adjacent occupied and used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the applicable governing agency and CHA's Designated Representative. Provide alternate routes around closed or obstructed traffic ways if required by the governing agency.

F. The Contractor shall clean and/or decontaminate equipment (tools, shovels, backhoes, pumps, hoses, etc.) with a jet washer or steam cleaner after completing work and prior to starting work with different classifications of wastes, recycled materials, or clean fill, as applicable. All cleaning and/or decontamination residuals must be handled in accordance with applicable federal, state, and local regulations at no additional cost to the CHA.

3.6 TRANSPORTATION

A. The Contractor shall remove soils, dusts, rocks, etc. from the exterior of trucks, trailers, or other heavy equipment leaving the site before they leave the site. All loads shall be tarped prior to leaving site and remain tarped until at the receiving facility.
B. All Subtitle D Wastes must be transported directly to the designated disposal facility from the site. Intermediate storage is not permitted.
C. The Contractor shall provide completed manifests and/or other waste removal documentation that requires signature for shipment to the CHA's Designated Representative and EC a minimum of two (2) days prior to shipment, as applicable.
D. The transporter shall present evidence of special waste hauling permits, as applicable, and CDL upon request by the CHA.
E. The Subtitle D Wastes shall be transported by a hauler licensed in the State of Illinois to transport applicable waste materials.
F. The Contractor shall have properly signed manifests or disposal documentation in hand prior to leaving the site with Subtitle D Wastes.

3.7 STOCKPILING

A. Contractor may temporarily stockpile Subtitle D Wastes on site for a maximum of five (5) working days, unless otherwise approved by the CHA.
B. The Contractor shall be responsible for keeping such stockpiles separated. If materials designated separately are commingled by Contractor, the Contractor shall dispose of such cross contaminated materials at his own expense. The Contractor will be responsible for all costs associated with the proper characterization, permitting, loading, transportation, and disposal of cross contaminated waste materials.
C. Acceptable locations for soil stockpiles shall be approved by the CHA's Designated Representative and it shall be in accordance with the City of Chicago requirements. The maximum height of the stockpile shall not exceed 10 feet. The Contractor shall containerize or place special waste, non-hazardous waste, or hazardous waste soils on 6 mil plastic sheeting, covered with 6 mil plastic sheeting, and protect with 12-inch to 18-inch berms until subsequent loading, transportation, and disposal. Base sheeting shall overlap the dike/berm. Temporary staging within an area already designated as contaminated may be performed by Contractor without underlying plastic and berm as with written approval of EC.
D. The Contractor shall not allow runoff from stockpiled Subtitle D Waste to enter storm drains or leave the site.

3.8 DUST CONTROL

A. The Contractor shall control dust by all necessary means, including but not limited to covering trucks, stockpiles and open materials, watering haul roads, sweeping paved roads, and limiting the speed of all on-site vehicles. Dust control measures shall comply with the National Emission Standards for Hazardous Air Pollutants, 40 CFR Part 63.
B. The Contractor shall prevent vehicles from tracking soil off site by all necessary means, including but not limited to construction of stone truck pads at site gates, and pressure washing vehicles and tires, as necessary.
C. Contractor shall perform all necessary activities to keep roadways clean throughout each day and for the duration of the project. The Contractor shall provide a street sweeper for street maintenance, if requested by the CHA, at no additional cost to the project.

3.9 LIQUID (WATER) MANAGEMENT

A. The Contractor shall manage the Work so as not to accumulate storm water on the site during excavation.

B. Prior to commencing Work, the Contractor shall provide a storm water management plan. This plan shall stipulate provisions for dewatering, pumping, collection, temporary storage, and discharge or disposal of storm water, perched water, and other liquids, contaminated and/or uncontaminated, at the site to facilitate soil removal and minimize disposal costs for contaminated fluids.

C. The Contractor shall ensure that contamination of water, perched water and previously uncontaminated water or perched water does not occur by preventing the contact of such liquid with materials that exceed 35 IAC 742 TACO Appendix B, Table A values for any of the 35 IAC 740 Appendix A Target Compound List (TCL) parameters. Earthen berms, plastic (polyethylene) sheeting, pumping, and other such means, as specified in the approved Storm Water Management Plan, may be used.

D. If the Contractor, through negligence, allows storm water to contact materials that exceed applicable TACO values, the water must be properly characterized and disposed of in accordance with all local, state, and federal regulations. The Contractor will be responsible for the additional costs incurred for characterization, storage, removal, transportation, and disposal costs.

E. Storm Water Run-on /Run-off, Groundwater, and Dewatering: Contractor shall manage and remove water from site excavation in accordance with the City of Chicago and MWRDGC's requirements. The Contractor shall not discharge onsite water into the City of Chicago sewer without first obtaining all required permits in accordance with the following procedures:

1. If there is no evidence of water contamination as determined by the CHA's Designated Representative and EC, Contractor shall obtain pumping permit from the City of Chicago Building Department.
2. If the CHA's Designated Representative or EC determined the presence of contaminated water at the site, Contractor shall collect and analyze representative water sample in accordance with MWRDGC Environmental Remediation Wastewater (ERW) Ordinance requirements. Contractor shall submit a copy of the analytical results to the CHA's Designated Representative and EC within seven (7) working days of sample collection.
3. If the analytical result of the water sample is below the maximum concentrations acceptable for discharge of ERW into sewerage system, the Contractor shall perform the following:

    a. Secure a Special Discharge Authorization from the MWRDGC for discharging contaminated water into the sewer system.
    b. Install and operate flow meters for measuring the volume of water discharged into the sewer system at each discharging manhole. Flow meters can be either installed on the settling tank, if used, or at each discharging manhole. The flow meter must meet the MWRDGC's requirements including a non-resettable totalizer and must be equipped with recorder charts. Totalizers must be read a minimum of once per week and a log of such readings, with the appropriate conversion factors, and recorder charts must be provided to the CHA's Designated Representative. The flow-measurement devices must be calibrated monthly and prior to its initial use. The accuracy of the device must be certified by a factory-authorized representative with documentation of this certification provided to the CHA's Designated Representative and submit to the MWRDGC.
    c. Collect and analyze representative water samples monthly for the parameters

required by the MWRDGC ERW special discharge authorization. Analytical results and sample collection, analysis and report certification shall be provided to CHA's Designated Representative and EC within 7 working days of sample collection.

4. If the analytical results of the water exceed the MWRDGC ERW ordinance requirements, Contractor shall a) install treatment system to reduce contaminant concentrations for discharge per above, or 2) Pump liquids into either a holding tank for future transportation and disposal at treatment facility, or pump directly into vacuum truck for disposal at a treatment facility. Contractor shall be responsible for all costs associated with installation of onsite treatment systems, pumping, onsite storage, transportation, and disposal.

3.10 DISPOSAL

A. Solids - The Contractor shall provide copies of weight tickets and/or volume (cubic yards/tonnage) receipts from the Permitted Subtitle D landfill facility accepting the Subtitle D Waste materials to the CHA's Designated Representative and EC within five business days.

B. Liquids - The Contractor shall provide copies of weight tickets and/or volume (gallons) receipts/manifests from the permitted treatment and/or disposal facility accepting Special Wastes to the CHA's Designated Representative and EC within five business days.

C. Contractor shall provide copies of completed tracking tickets/manifests executed by the CHA's Designated Representative or EC, transporter and the permitted facility accepting the Subtitle D Waste materials to the CHA's Designated Representative or EC within five business days of off-site removal. Original manifests forwarded from the receiving facility to the Generator will not be available to Contractor. Contractor shall collect, organize by date, and submit transporter copy to the CHA's Designated Representative and EC. Submittal shall include summary table which identifies manifest number, date, transporter, and associated weight ticket or volume receipt, as applicable.

3.11 NOISE CONTROL

A. The Contractor shall not start any work activities prior to the time specified in the City of Chicago Noise Ordinance.

B. The Contractor shall control the noise in accordance with the City of Chicago Noise Ordinance or as directed by the CHA's Designated Representative during normal operating hours.

3.12 QUALITY CONTROL

A. Visual inspections and damage repairs shall be made daily by the Contractor to assure that erosion, drainage, and containment control measures are functioning properly.

B. The Contractor shall take all necessary precautions to protect structures, equipment, pavement, walks and utilities against movement or settlement during Work.

C. Damage: The Contractor shall promptly replace or repair any damage caused to adjacent pavement, utilities, or facilities by removal operations at no additional cost to CHA. Work shall be performed to the satisfaction of the CHA's Designated Representative.

D. Submittal Timeframe Compliance: The Contractor shall ensure that all required submittals follow time frames specified.

E. Utility Services: The Contractor shall maintain existing utilities and protect against damage during removal operations.

**END OF SECTION**

**SECTION 31 23 18.14**

**CLEAN CONSTRUCTION OR DEMOLITION DEBRIS AND UNCONTAMINATED SOIL DISPOSAL**

## PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings

1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. This section applies for all demolition, construction and renovation projects that require removal and off-site transfer of Clean Construction or Demolition Debris (CCDD) and Uncontaminated Soil as defined in this Specification.

1.3 INTRODUCTION

A. Description of Work: This specification is for the excavation, loading and off-site transfer of CCDD and Uncontaminated Soil to permitted CCDD fill sites for use as fill. The Contractor shall perform the Work in accordance with all applicable local, state, and federal regulations. The Work shall include the following:

1. CCDD Disposal:

a. CCDD shall be taken to permitted and available CCDD fill site(s). Uncontaminated asphalt, clean concrete and/or brick that are free of other soil/fill or debris shall be taken to CHA approved recycling facilities for recycling.
b. Prior to Work, the Contractor shall identify the selected CCDD fill site and/or recycling facility. Once identified in the formal submittals required in Subsection 1.5, the Contractor may not change the CCDD fill site or recycling facility without written authorization from the EC.
c. The Contractor shall identify the hauler or haulers to be used for the transportation of CCDD. Once identified in the formal submittals required in Subsection 1.5, the Contractor may not change the haulers without written authorization from the CHA's Designated Representative and EC.
d. At least 48 hours prior to commencing any excavation activities, the Contractor shall contact the CHA's Designated Representative and EC.
e. The Contractor shall excavate, load, and transport of identified CCDD to the identified CCDD fill site or recycling facility.
f. The Contractor shall provide copies of CCDD fill site receipts to the CHA's Designated Representative and EC. The fill site receipts shall be per-truck and shall be legible. The receipts must include the date and time of transfer, the name of the hauler, the receiving fill site, and the volume of CCDD material transferred per truck. The Contractor shall also provide a Daily Report to the CHA's Designated Representative and EC. The Daily Report shall include, at a minimum, the name of

hauler, the name of the receiving fill site, and the volume of CCDD disposed of or recycled that day. The fill site receipts shall be attached to the Daily Report.

2. Uncontaminated Soil Disposal:

   a. Uncontaminated Soil shall be transferred off-site to a permitted and available CCDD facility.
   b. A Source Site Certification (IEPA form LPC-662 or LPC-663) will be provided by the EC. The Contractor shall select a CCDD facility that will accept the designated soils based solely upon the LPC-662 or LPC-663 and supporting information. No further analytical shall be conducted or provided by Contractor.
   c. Contractor shall provide verification of CCDD approval to the CHA's Designated Representative and EC. Contractor may not change the CCDD fill site without written authorization from EC.
   d. Contractor shall identify the hauler or haulers to be used for the transportation of Uncontaminated Soils to the selected fill site. Once identified in the formal submittals required in Subsection 1.5, the Contractor may not change the haulers without written authorization from CHA's Designated Representative and EC.
   e. At least 48 hours prior to commencing any excavation activities, the Contractor shall contact the CHA's Designated Representative and EC. The EC will document location and approximate depth(s) of excavated materials and screen Uncontaminated Soils loaded into hauling trucks prior to leaving the CHA project site.
   f. The Contractor shall excavate, load, and transport the identified Uncontaminated Soil to the selected CCDD fill site.
   g. The Contractor shall provide copies of CCDD fill site receipts to the CHA's Designated Representative and EC. The fill site receipts shall be per-truck and shall be legible. The receipts must include the date and time of transfer, the name of the hauler, the name of the receiving fill site, and the volume of Uncontaminated Soil transferred per truck. The Contractor shall also provide a Daily Report to the CHA's Designated Representative and EC. The Daily Report shall include, at a minimum, the name of hauler(s), the name of the receiving fill site(s), and the volume of Uncontaminated Soil transferred that day. The fill site receipts shall be attached to the Daily Report.

3. Other Materials:

   a. Material removed from the site that is not identified as CCDD or Uncontaminated Soil should be managed in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal", and/or Section 01 52 40 "Construction Waste Management and Disposal", as applicable.

## 1.4 DEFINITIONS

A. Clean Construction or Demolition Debris (CCDD) means any of the following materials, alone or in combination, that (i) have been generated from construction or demolition activities and (ii) are *uncontaminated*:

   1. broken concrete without protruding metal bars,
   2. bricks,
   3. rock,

4. stone,
5. reclaimed or other asphalt pavement

Uncontaminated soil which is comingled with any of the above materials is also considered CCDD. [415 ILCS 5/3.160(b)]

B. Chicago Housing Authority (CHA) means the Owner of the property and the authority ordering the work specified herein.

C. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

D. Environmental Consultant (EC) means the entity with overall responsibility for the direction and control of the environmental investigations, assessments, designs, and supervision of remediation work.

E. General Construction and Demolition (C&D) debris means non-hazardous, uncontaminated materials resulting from construction, remodeling, repair, and demolition of utilities, structures, and roads as defined in Section 3.160 of the Environmental Protection Act, 415 Illinois Compiled Statutes (ILCS) 5/3.160 and regulated under Title 35: Environmental Protection; Subtitle G: Waste Disposal; Chapter I: Pollution Control Board; Subchapter i: Solid Waste and Special Waste Hauling. C&D debris may include soil, wall coverings, reclaimed asphalt pavement, rock, plaster, glass, non-hazardous painted wood, drywall, plastics, non-hazardous coated wood, non-asbestos insulation, bricks, wood products, roofing shingles, concrete, and general roof coverings.

F. IEPA means Illinois Environmental Protection Agency.

G. LPE means licensed professional engineer.

H. MWRDGC means the: Metropolitan Water Reclamation District of Greater Chicago.

I. OSHA means the federal agency with responsibility for worker safety, the Occupational Safety and Health Administration.

J. Soil means any granular or cohesive materials designated for removal as specified in the bid documents and includes soils and soil-like materials, such as clay, that are determined to be Uncontaminated Soil, Contaminated Soil, and Special and/or Hazardous Waste soil.

K. Storm water means water deposited at the site in the form of rain, snow, or other natural weather event.

L. Uncontaminated Soil means soil generated during construction, remodeling, repair or demolition of utilities, structures and roads that does not contain contaminants in concentrations that pose a threat to human health and safety and the environment. [415 ILCS 5/3.160(c)]

M. Work means the obligations of the Contractor under the Contract Documents. Work includes, unless specifically excepted by the Contract Documents, the furnishing of all materials, labor, equipment, and supplies necessary for the full performance and completion of the requirements of the Contract Documents. Work also means that which is furnished, produced, constructed, or built pursuant to the Contract Documents.

1.5 SUBMITTALS

A. The Contractor shall ensure that submittals are provided in compliance with specified time frame(s) to avoid delays in Work.

B. The Contractor shall prepare and submit the following documents to the CHA's Designated Representative and EC for the off-site removal and transfer of CCDD:

1. Name, address, and telephone number of the CCDD fill site where the CCDD will be transported. This submittal must be made at least five days prior to removal of any materials from the site. Once this submittal is made, the Contractor cannot change the fill site without written authorization from the CHA's Designated Representative. This information should include, at a minimum, the following:

   a. CCDD fill site name and address and telephone number.
   b. Site contact information, including contact person and phone number.
   c. Fill Site Identification number assigned by the IEPA.
   d. Executed CCDD Acceptance Agreement from the facility, setting forth its agreement and authorization to accept the identified material.

   Once this submittal is made, the Contractor cannot change the fill site without written authorization from the EC.

2. Name of Haulers to be used for the transportation of CCDD and Recycled Material. This submittal must be made at least five days prior to removal of any materials from the site. This information shall include, at a minimum, the following:

   a. Hauler name, address, contact information, including name and telephone number of authorized representatives.
   b. Any relevant transportation license numbers.

   Once this submittal is made, the Contractor cannot change the haulers without written authorization from the Commission Representative and EC.

3. Storm Water Management Plan (SWP) - Prior to commencing any Work at the site, the Contractor shall provide a Storm Water Management Plan stipulating any required permits, such as a city storm water discharge approval, or MWRDGC Discharge Authorization and a SWP. The SWP shall contain provisions for dewatering, pumping, collection, temporary storage, and discharge or disposal of storm water, perched water, and other liquids, to facilitate soil removal. The SWP should include provisions for preventing storm water from entering excavation areas, or from going off-site. These may include, but not be limited to, surface grading, pumping and/or combination of silt fence, sandbags, tarpaulins, plastic sheeting, and movable straw bales. This SWP shall comply with all relevant contract documents and specifications, any relevant permit conditions, and all local, state, and federal laws and regulations, including those of the City of Chicago Department of Water, the MWRDGC, and the IEPA, as relevant.

4. Copy of the Storm Water Discharge Approval from the City of Chicago Building Department and, if required, the MWRDGC Discharge Authorization, prior to pumping water into the City of Chicago sewer system.

5. Soil Management Plan (SMP). Prior to commencing any Work, the Contractor shall provide a SMP outlining proposed excavation Work sequences and procedures to separate each type of material to be removed from the site, separating any contaminated materials from any uncontaminated materials, and shall ensure that haulers are fully informed as to the appropriate destination for the materials. The SMP shall show the locations of each type of material to be stored on site, pending reuse as specified in the Contract Documents, or off-site transfer to appropriate location.

6. Reports and Other Submissions. The Contractor shall provide the following on a weekly basis:

    a. Copies of all fully executed CCDD facility receipts, which shall be legible and dated and shall contain a complete description of the material taken per truck. Tracking receipts may be provided as part of load verification and shall be utilized by the Contractor for CCDD materials transported off-site as requested by EC.
    b. Copies of daily reports providing information regarding hauler names and volume or weight of material removed, and location taken, per truck.

C. Contractor shall provide the following for each Recycling Facility:

1. Name, Address, and Contact Information for each proposed Recycling Facility.
2. Copy of document (license, permit, etc.) that indicates that the facility is authorized to operate a recycling operation for proposed material(s).
3. Copies of recycling facility receipts for each load of material transported to the approved recycling facility.

1.6 SUBMITTAL REVIEW

3.01 Review of submittals or any comments made does not relieve the Contractor from compliance with the requirements of the drawings and specifications. The purpose of this check is to review for general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for confirming and correlating all quantities and dimensions; electing techniques of construction; coordinating the Work; and performing the Work in a safe and satisfactory manner, in compliance with all contract documents, specifications, and applicable laws and regulations.

3.02 The Contractor must not begin any Work applicable to this section until all required submittals have been reviewed and accepted by the CHA's Designated Representative and EC.

3.03 To ensure appropriate oversight of removal activities, the Contractor shall provide notification to the CHA's Designated Representative and EC no less than forty-eight (48) business hours prior to excavating, loading, and transporting of any materials from the site. The CHA's Designated Representative shall provide a representative onsite for field verification of the CCDD and Uncontaminated Soil.

1.7 RECORD KEEPING

A. The Contractor shall maintain and provide all records provided for in this Section. The Contractor shall also provide documentation of labor, equipment, and materials used for the CCDD and Uncontaminated Soil removal as required to fulfill the scope of work described in the Contract Document or as requested by the CHA's Designated Representative.

## PART 2 - PRODUCTS

2.1 REMOVAL OF CCDD AND UNCONTAMINATED SOIL

A. THE CONTRACTOR SHALL FURNISH ALL NECESSARY MEANS, PRODUCTS, TOOLS, AND EQUIPMENT REQUIRED TO REMOVE AND DISPOSE CCDD AND UNCONTAMINATED SOIL FROM THE SITE PER CONTRACT DOCUMENTS AND AS DIRECTED BY THE CHA'S DESIGNATED REPRESENTATIVE.

B. The Contractor shall also furnish all necessary means, products, tools, and equipment required to fulfill the scope of work described in the contract specifications and drawings. The Contractor, by submitting a bid for the Work, represents itself as knowledgeable and an expert in the performance of the Work, and includes all things usually and customarily necessary to provide a complete and finished job, whether specifically mentioned or not.

## PART 3 - EXECUTION

3.1 Authorizations

A. The Contractor shall obtain appropriate authorization from the permitted CCDD fill site, Uncontaminated Soil fill site(s), and from the authorized recycling facility where the applicable material will be taken.

3.2 Material Sampling

3.01 As directed by the CHA's Designated Representative, the Contractor shall provide the necessary equipment and manpower to assist the EC in any necessary field verifications to complete these activities at no additional cost to the project.

3.02 The Contractor shall not perform any field sampling or testing without a written authorization from CHA. All field sampling and testing activities shall be coordinated with the EC for oversight and documentation.

3.3 Excavation

A. The Contractor shall perform all site excavation in accordance with the Contract Documents.

B. The Contractor must have a complete plan for the entire process of soil removal and disposal in accordance with the project requirements. Contractor must provide schedule of all Work activities in accordance with the approved construction schedule.

C. The Contractor shall perform excavation of materials in accordance with all applicable regulations and project specifications. All excavation shall be performed in accordance with OSHA requirements and guidelines.

D. The Contractor shall immediately notify the CHA's Designated Representative and EC if any materials, (solid or liquid) requiring special handling (i.e., contaminated soil, soil with odors, or liquids) are encountered during excavation. Such materials shall be separately stockpiled and shall not be loaded into hauling trucks without a written authorization from CHA's Designated Representative.

E. The Contractor shall coordinate all soil excavation and hauling from the site activities with the EC. The Contractor must provide a written notification to the CHA's Designated Representative and EC at least 48-hour prior to starting any soil excavation and hauling from the site.

F. The Contractor shall review the Contract Documents to become familiar with locations of all types of materials to be excavated as part of Work. The Contractor shall excavate each type of material separately as practical and consistent with the Contractor's SMP and shall clean excavation equipment prior to excavating CCDD and Uncontaminated Soil.

G. The Contractor shall be responsible for maintaining the structural integrity of all surrounding streets, underground utilities, buildings, and structures (walkways, sidewalks, underground tunnels, etc.)

H. The Contractor shall secure, shore, and brace where sloping is not possible either because of space restrictions or stability of material excavated. Excavations shall be braced or sloped in compliance to the latest OSHA requirements and shall comply with local codes, authorities having jurisdiction, and the City of Chicago, and maintain same. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable conditions. Maintain shoring and bracing in excavations regardless of the time excavations will remain open. Carry down shoring and bracing as the excavation progresses.

## 3.4 DECONTAMINATION

A. The Contractor shall clean and/or decontaminate excavation equipment (tools, shovels, backhoes, etc.) with a jet washer or steam cleaner prior to excavating Uncontaminated Soil, other CCDD materials or materials designated for recycling. All cleaning and/or decontamination residuals must be collected and disposed of in accordance with applicable local, state, and federal regulations.

B. The Contractor shall remove soils, dusts, rocks, etc. from the exterior of trucks, trailers, or other heavy equipment prior to leaving the site.

C. The Contractor shall not allow equipment or trucks to leave the site with water leaking or mud dripping or caked to the equipment or trucks.

## 3.5 STOCKPILING

A. The Contractor may stockpile excavated materials on site as approved by the CHA's Designated Representative and as set forth in the Contractor's approved SMP. The location of the stockpile area shall be approved by the CHA's Designated Representative and it shall be in accordance with the City of Chicago requirements, including Section 13-32 & 125 of the Municipal Code. The maximum height of the stockpile is 20 feet, provided appropriate setbacks, as set forth in the Code, are met.

B. The Contractor shall be responsible for keeping CCDD and Uncontaminated Soil separated from Contaminated Soils and General Construction and Demolition Debris, Special Waste, and Hazardous Waste. If CCDD and Uncontaminated Soil meet Contaminated Soils or General Construction or Demolition Debris, Special Waste or Hazardous Waste, the former CCDD and Uncontaminated Soils will now be considered contaminated materials, and the Contractor shall dispose of newly designated soils as contaminated soils at his own expense in accordance with

Section 31 23 18.13 as applicable. The Contractor will be responsible for any sampling analysis costs associated with characterization of soil that has become contaminated pursuant to this Subsection.

3.6 LOADING

A. The Contractor shall notify the CHA's Designated Representative and EC 48 hours in advance of soil loading and hauling activities. No soil shall be removed from the site without the presence of the EC.

B. Prior to loading, the Contractor shall prepare and provide hauler with appropriately marked CCDD tracking receipts, for acceptance and confirmation at the receiving site.

C. The Contractor shall load excavated materials directly from the site or from temporary stockpiles into hauling trucks equipped with tarp for direct transportation to the approved CCDD fill site or recycling facility.

D. The Contractor shall conduct operations in a manner that minimizes interference with roads, streets, walks and other adjacent occupied and used facilities. The Contractor shall not close or obstruct streets, walks or other occupied or used facilities without permission from the applicable governing agency and the Commission Representative. If required by the appropriate governmental entity, the Contractor shall provide alternate routes around closed or obstructed traffic ways.

E. The Contractor shall ensure compliance with all State and local Road/Street weight limits.

3.7 TRANSPORTATION

A. All trucks shall be properly covered prior to leaving the site as required by the City of Chicago Municipal Code.

B. All CCDD and Uncontaminated Soil shall be transported directly to the approved CCDD fill site or recycling facility daily. No off-site temporary storage is allowed. All materials not transported to the CCDD facility, Uncontaminated Soil facility or recycling facility shall be returned to the project site for overnight storage.

C. The Contractor shall immediately notify the CHA's Designated Representative and EC if any CCDD or Uncontaminated Soil loads are rejected by the CCDD fill operation.

D. The Contractor shall provide completed and executed copies of disposal/recycling CCDD tracking receipts to the CHA's Designated Representative on weekly basis.

E. Drivers shall hold, and present upon request, a current valid Commercial Driver's License (CDL).

3.8 Stormwater runoff and groundwater Management

3.01 The Contractor shall manage the Work so as not to accumulate storm water on the site during excavation.

3.02 The Contractor shall prevent storm water, groundwater, or perched water from entering excavation areas. The Contractor shall implement the approved storm water management plan in accordance with conditions, or as directed by the CHA's Designated Representative.

3.03 The Contractor shall manage and remove water from site excavation in accordance with the City of Chicago and MWRDGC's requirements. The Contractor shall not discharge onsite water into the City of Chicago sewer without first obtaining all required permits from the City of Chicago Building Department and MWRDGC.

3.9 DUST CONTROL

A. The Contractor shall control dust by all necessary means, including but not limited to covering trucks, stockpiles and open materials, watering haul roads, sweeping paved roads, and limiting the speed of all on-site vehicles. Dust control measures shall comply with the National Emission Standards for Hazardous Air Pollutants, 40 CFR Part 63.

B. The Contractor shall not create dust and shall maintain adequate dust suppression equipment on site if conditions warrant.

C. The Contractor shall maintain streets clean and free of mud and dirt. Contractor shall perform all necessary activities to keep roadways clean throughout each day and for the duration of the project. The Contractor shall provide a street sweeper for street maintenance, if requested by the CHA, at no additional cost to the project.

3.10 Noise Control

A. The Contractor shall not start any Work activities prior to the time specified in the City of Chicago Noise Ordinance.

B. The Contractor shall control the noise, in accordance with the City of Chicago Noise Ordinance, or as directed by the CHA's Designated Representative during normal operating hours.

3.11 QUALITY CONTROL

A. Visual inspections and damage repairs shall be made daily by the Contractor to assure that erosion, drainage, and containment control measures are functioning properly.

B. The Contractor shall take all necessary precautions to protect structures, equipment, pavement, walks and utilities against movement or settlement during Work.

C. Damage: The Contractor shall promptly replace or repair any damage caused to adjacent pavement, utilities, or facilities by removal operations at no additional cost to CHA. Work shall be performed to the satisfaction of the CHA's Designated Representative.

D. Submittal Timeframe Compliance: The Contractor shall ensure that all required submittals follow time frames specified.

E. Utility Services: The Contractor shall maintain existing utilities and protect against damage during removal operations.

**END OF SECTION**

**SECTION 31 23 23**

**ACCEPTANCE OF BACKFILL, TOP SOIL & CU STRUCTURAL SOIL**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Contract Drawings

### 1.2 APPLICABILITY

A. These environmental requirements apply to all Chicago Housing Authority (CHA) projects. This section applies for all demolition, construction and renovation projects that require the importation of backfill material. The materials specifically excluded from the requirements of this Section include Wood Mulch and Sod.

### 1.3 INTRODUCTION

A. Work Included: This specification is for the testing and approval of ALL imported Backfill, Top Soil and CU Structural Soil imported to a CHA project by the Contractor. The imported backfill is differentiated into two types for the purpose of this Specification:

1. Virgin Source Materials (Quarry Gravel)
2. Non-Virgin Source Materials (All Other Imported Backfill Materials).

B. All imported source materials must meet the requirements presented in this Specification. No proposed imported material will be accepted for use prior to its pre-approval from the Environmental Consultant and Chicago Housing Authority. The Contractor shall perform the work under this section in accordance with all local, state, and federal rules and regulations including but not limited to Illinois EPA, United States Environmental Protection Agency (USEPA), Illinois Department of Transportation, and Occupational Safety and Health Agency (OSHA) regulations.

### 1.4 DEFINITIONS

A. Agency means Illinois Environmental Protection Agency (IEPA).

B. Backfill means any granular or cohesive material used to fill an excavation or bring property to design grade as specified in the Architect/Engineer drawings and specifications.

C. Chicago Housing Authority (CHA) means the owner of the property and the authority ordering the work specified herein.

D. CHA's Designated Representative means the Chicago Housing Authority person or entity designated as the official representative of the CHA in connection with a project.

E. CU Structural Soil means a uniformly blended mixture of crushed stone, clay, loam and hydrogel by weight consisting of approximately 83% crushed limestone (3/4 to 1.5 inch, highly angular with limited fines), 17% clay loam and hydrogel (1 oz. per 200 pounds of stone).

F. IEPA means Illinois Environmental Protection Agency.

G. Environmental Consultant (EC) means the entity with overall responsibility for the direction and control of the environmental investigations, assessments, designs, and supervision of remediation work.

H. Non-Virgin Source Materials means any backfill that does not meet the definition of Virgin Source Materials (Quarry Gravel)

I. Target Compound List (TCL) means the parameters listed in 35 Illinois Administrative Code (Ill. Adm. Code) 740 Appendix A Target Compound List Tables A, B, C and D.

J. Tiered Approach to Corrective Action Objectives (TACO): 35 Ill. Adm. Code 742.

K. Top Soil means any soils placed to design grade and used to promote vegetative growth.

L. User means the entity for which or on whose behalf CHA has undertaken to cause the Work to be performed.

M. Virgin Source Materials (Quarry Gravel) means the gravel backfill which is mined directly from a natural geologic rock formation and produced and delivered directly from a quarry.

N. Work means the obligations of the Contractor under the Contract Documents. Work includes, unless specifically excepted by the Contract Documents, the furnishing of all materials, labor, equipment, supplies, necessary for the full performance and completion of the requirements of the Contract Documents. Work also means that which is furnished, produced, constructed, or built pursuant to the Contract Documents.

## 1.5 SUBMITTALS

A. The Contractor shall ensure that submittals are provided in compliance with specified time frame(s) to avoid delays in Work. Contractor shall be responsible to coordinate approval of source materials per this specification with other required approvals per the architectural and engineering specifications and requirements.

B. Virgin Source Materials (Quarry Gravel) Submittals

1. Letter signed by authorized representative from the quarry on their letterhead indicating the material is being mined from natural geologic rock formation.
2. Daily reports and import tickets for all materials to EC or the CHA's Designated Representative on daily basis. Import tickets shall include source location and import date on each document.

C. Non-Virgin Source Materials (All Other Imported Backfill Materials) Submittals

1. Select and perform historical and governmental database document research of source material location. Research shall include current and historical aerials, Sanborn Maps, and or topographic maps of the source location.
2. Source location information shall include map of source site, latitude and longitude, the name and phone number of the owner of the source materials, and the location where the source materials are being derived from at the site.
3. Sample collector information including name, company, address and telephone number of consultant/entity that performed sampling and their specific handling criteria for each sample collected from source location.
4. Laboratory analysis data for TCL parameters from laboratory accredited in accordance with the Illinois Administrative Code, Title 35, Subtitle A Chapter II, Part 186. The date of collection shall be within 60 days of importing such material to a CHA project.
5. Summary of Analytical Data. The report shall include a tabulation of sampling results compared to most stringent TACO Tier 1 remediation objectives for the TCL parameters.
6. Daily reports and import tickets for all materials delivered to the site shall be provided to EC or the CHA's Designated Representative on daily basis. Import tickets shall include source name, location, and date of pickup on each document.

D. Pre and Post Backfill Surveys for each Remediation Area.

1.6 SUBMITTAL REVIEW

A. Review of submittals or any comments made does not relieve the Contractor from compliance with the requirements of the drawings and specifications. The purpose of this check is to review for general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for confirming and correlating all quantities and dimensions; electing techniques of construction; coordinating the Work; and performing the Work in a safe and satisfactory manner.

1.7 NOTIFICATIONS

A. The Contractor shall notify CHA's Designated Representative and EC a minimum of 48 hours prior to sampling source Non-Virgin Source Materials. EC may visit source location to monitor sampling activities.

B. The Contractor shall notify the CHA's Designated Representative and EC a minimum of 48 hours prior to transporting any Backfill, Top Soil and CU Structural Soil to the site. The EC may provide a representative onsite for field screening using a Photo-ionization Detector (PID).

1.8 RECORDKEEPING

A. The Contractor shall provide documentation of labor, equipment, and materials used for importation of backfill when requested by the CHA's Designated Representative.

**PART 2 - PRODUCTS**

2.1 BACKFILL, TOP SOIL, CU STRUCTURAL SOIL

A. The Contractor shall supply only Backfill, Top Soil and CU Structural Soil that meets the project specified requirements as referenced in the Contract Documents.

B. The Contractor shall be responsible to ensure that approval per this Specification AND approval per the applicable architectural/engineering specifications is provided by the CHA's Designated Representative prior to importing any backfill materials to a CHA project.

**PART 3 - EXECUTION**

3.1 AUTHORIZATIONS

A. The Contractor shall have written approval from the CHA's Designated Representative and EC prior to importing any Backfill, Top Soil, or CU Structural Soil to the CHA project.

B. The Contractor shall not place Backfill, Top Soil or CU Structural Soil without approval of the CHA's Designated Representative. If the Contractor places Backfill, Top Soil or CU Structural Soil without obtaining approval from the CHA's Designated Representative, the Backfill, Top Soil or CU Structural Soil shall be excavated, if required, and replaced at the Contractor's expense.

3.2 MATERIAL SAMPLING (NON-VIRGIN SOURCE MATERIALS ONLY)

A. The requirements of Section 3.2 only apply to Non-Virgin Source Materials.

B. The Contractor shall collect sufficient amount of sample from source material(s) for analytical testing. Composite samples are not permitted for volatile organic samples.

C. The Contractor shall collect representative samples in accordance with IEPA approved methods for TCL parameter laboratory analysis. All containers used shall be pre-cleaned to EPA standards. Samples shall be immediately placed in cooler with ice or ice packs and forwarded to laboratory. A chain of custody should be prepared for all samples.

D. The Contractor shall verify that these materials do not exceed most stringent TACO Tier 1 remediation objectives for the TCL parameters.

E. The Contractor shall prepare summary of the sample collection and data analysis. The report should include a tabulation of sampling results compared to the most stringent Tier 1 remediation objectives for residential properties. The sample collection date for any backfill shall be within 60 days of importing such material to a CHA project.

F. The Contractor is responsible for payment of all Backfill, Top Soil and CU Structural Soil sampling, historical data and analytical fees.

G. The EC may collect samples of Backfill, Top Soil or CU Structural Soil for laboratory analysis on behalf of the CHA to verify source materials comply with specifications. Should results indicate exceedances of the most stringent TACO Tier 1 remediation objectives for the TCL parameters, Contractor shall be responsible for removal and replacement at no additional cost to the project.

H. The EC may collect samples for field PID screening. The Contractor shall provide the necessary equipment and manpower to assist the EC to collect materials to be sampled at no additional cost to the project and in compliance with OSHA and all other Rules and Regulations.

## 3.3 SAMPLE FREQUENCY (NON-VIRGIN SOURCE MATERIALS ONLY)

A. The requirements of Section 3.3 only apply to Non-Virgin Source Materials.

B. Contractor shall provide a minimum of one sample for each type of Non-Virgin Source Material imported to CHA project.

C. The Contractor shall provide one representative sample analyzed for TCL parameters per every 1,000 tons/500 cubic yards of material.

D. The date of the collection of the source samples for laboratory analysis shall be within 60 days of importing such material to a CHA project.

E. The Contractor shall be responsible for all additional sampling and analysis to comply with specified analysis frequency and volume.

F. The Contractor shall be responsible for additional TCL laboratory analysis of all individual components/amendments added to materials if not included in original representative sample analysis.

## 3.4 TRANSPORTATION AND DELIVERY

A. Drivers shall hold, and present upon request, a current valid Commercial Driver's License (CDL).

B. The Contractor is responsible for complying with State and local road/street weight limits.

C. The Contractor must transport all materials in covered trailers.

D. The Contractor shall place Backfill, Top Soil and CU Structural Soil to ensure minimum interference with roads, streets, walks and other adjacent occupied and used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the applicable governing agency and the CHA's Designated Representative. Provide alternate routes around closed or obstructed traffic ways if required by the governing agency.

E. All Backfill, Top Soil, and CU Structural Soil shall be transported directly to the project Site from the approved source location. No off-site temporary storage is allowed.

F. The Contractor shall provide and complete copies of all daily reports, weight tickets/delivery tickets (as applicable) for each load of Backfill, Top Soil, and CU Structural Soil to the CHA's Designated Representative and/or EC daily or as directed by the CHA's Designated Representative.

## 3.5 STOCKPILING

A. The Contractor may stockpile source materials on-site. The location of the stockpile area shall be approved by the CHA's Designated Representative and it shall be in accordance with the City of Chicago requirements. The maximum height of the stockpile shall not exceed 10 feet.

B. The Contractor shall be responsible for keeping approved Backfill, Top Soil and CU Structural Soil separated from soils classified differently until final placement per the Contract Documents. If approved Backfill, Top Soil and CU Structural Soil comes in contact with these other soils prior to final placement, the materials will now be considered same as other classified materials, and the Contractor shall dispose of newly designated soils as contaminated and provide replacement materials per Contract Documents at his own expense. Disposal shall be to Subtitle D Landfill unless otherwise directed by EC. The Contractor will be responsible for sampling analysis costs associated with characterization of newly designated contaminated soil.

## 3.6 PLACEMENT

A. All Backfill, Top Soil and CU Structural Soil shall be placed in accordance with the engineering/architectural and remediation plans, as applicable.

B. The Contractor shall not place backfill material without approval of the CHA's Designated Representative and EC. If the Contractor backfills the excavation area without obtaining approval from the CHA's Designated Representative, the backfill materials shall be excavated, if required, at the Contractor's expense.

C. Contractor shall perform surveys of all Remediation Areas prior to backfill and upon completion of backfill placement for depth verification. Surveys shall include one survey point for every 2500 square feet of area and no less than 3 points for any noncontiguous area under 2500 square feet. Surveys shall be performed by Illinois Licensed Surveyor and submitted within five working days of completion.

## 3.7 DUST CONTROL

A. The Contractor shall control dust by all necessary means, including but not limited to covering trucks, stockpiles and open materials, watering haul roads, sweeping paved roads, and limiting the speed of all on-site vehicles.

## 3.8 QUALITY CONTROL

A. The Contractor shall take all necessary precautions to protect structures, equipment, pavement, walks and utilities against movement or settlement during the course of work.

B. Damages: Promptly replace or repair any damage caused to adjacent pavement, utilities or facilities by removal operations at no additional cost. Work shall be performed to the satisfaction of the CHA's Designated Representative.

C. Utility Services: Maintain existing utilities and protect against damage during placement of backfill, top soil and CU Structural Soil.

D. Visual Inspections: Perform visual inspections of each load of imported material to ensure that it is in conformance with the approved source and reject any material that has not been approved.

E. Submittal Timeframe Compliance: Ensure that approved source data submitted is in compliance with time frames specified.

F. Imported Material Inspections: Perform periodic checks of fill source locations to identify any change in material characteristics, as applicable.

**END OF SECTION**

**SECTION 31 50 00**

**EARTH RETENTION SYSTEM**

## PART 1 GENERAL

1.01 SUMMARY

A. The section includes Temporary Earth Retention System (ERS), required during construction as shown on the drawings.

1.02 RELATED SECTIONS

A Related Work specified in other section includes, but is not limited to, the following:

1. Division 01 - General Requirements.
2. Section 01 50 00 - Construction Facilities and Temporary Controls
3. Section 01 33 00 - Submittals
4. Section 05 12 00 - Structural Steel
7. Section 31 22 14 - Earthwork
8. Section 31 23 18 -Soil, Fill, Backfill CU Structural Soil and Construction and Demolition debris removal

B. Comply with the "American Iron and Steel (AIS)" requirements as contained in Section 436 of the Consolidated Appropriations Act, 2014, further described in Section 01 11 10 Compliance with Iron and Steel Requirements

1.03 PERFORMANCE REQUIREMENTS

A. A conceptual temporary ERS is indicated and shown on the drawings. Contractor is fully responsible for design and installation of a similar or any other alternate temporary ERS acceptable to ARCHITECT/ENGINEER. The limits and size and type of ERS shown on the drawings are only conceptual. Contractor is fully responsible to design and install all ERS as needed to complete the construction of this project as indicated on the drawing. Contractor is responsible for all ERS whether shown or as needed to construct the project.

B. Prepare and Submit ERS plans and schedule for approval by ARCHITECT/ENGINEER. Coordinate Work with other construction activities.

C. Design**,** furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of soil and hydrostatic pressure, superimposed and construction loads. Use sheet piling as required. Limit deflections to ¼" and protect from damage existing and proposed construction including, but not limited to, pipe lines, utilities, roadways, and other facilities.

D. Lateral and vertical movement of the ERS must be limited to ¼".

E. Common types of excavation ERS include, but are not limited to, singular or multiple stages comprised of cantilevered or internally braced soldier piles and lagging, steel sheet pile wall,

timber sheet pile wall, trench box, or combinations thereof. Trench box temporary excavation support system is only acceptable for pipe or utility trench excavations. Temporary unsupported open cut excavation with stable sloping sides is allowed where applicable.

F. Construction of the temporary excavation ERS must not disturb the existing structures or the completed proposed structures. Damage to such structures must be repaired at no additional cost to the Owner.

G. Install sheet piling by push method. The use of driven piling causing vibrations in existing facilities is not allowed.

H. Provide deformation monitoring. At a minimum, provide monitoring points on the adjacent buildings to assure that integrity of all existing facilities are maintained during construction.

I. Construction operations are not to exceed specified noise limits in accordance with Specification 01 50 00.

J. Bear full responsibility of correcting any failure, damage, subsidence, upheaval or cave-ins as a result of improper installation, maintenance or design of the temporary ERS. Contractor is responsible for payment of all claims, costs and damages that arise as a result of the Work performed, at no additional cost to the Owner.

1.04 SUBMITTALS

A. Submit all calculations and Shop Drawings in accordance with Section 01 33 00.

B. Design ERS, including comprehensive engineering analysis by a Licensed Structural Engineer in Illinois, using performance requirements and design criteria indicated here. Design ERS to resist all applicable loads from soil and live loads. ARCHITECT/ENGINEER will review calculations and shop drawings prior to start of work.

C. Other Informational Submittals:

1. Photographs: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.

2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

    a. Note locations and capping depth of wells and well points.

1.05 QUALITY ASSURANCE

A. Pre-installation Conference: Conduct conference as scheduled by ARCHITECT/ENGINEER.

1. Review methods and procedures related to ERS including, but not limited to, the following:

a. Existing utilities and subsurface conditions
b. Proposed excavations
c. Proposed equipment
d. Monitoring of ERS
e. Working area location and stability
f. Coordination with dewatering

B. Temporary Excavation Support System Installer's Qualifications:

1. Substantial demonstrated experience in the installation of similar types and equal complexity as the proposed system.

2. Completed successful excavation support systems of similar type and equal complexity as the proposed system.

C. Install all temporary excavation support systems under the supervision of an installer having the above qualifications.

D. All welding must be performed in accordance with AWS D1.1.

E. Use of Tieback System is not permitted.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Notify Office of Underground Coordination (OUC). Bear full responsibility to fully identify, locate and coordinate with all existing utilities in the field that may be impacted by construction prior to installation of ERS. Do not interrupt any utility serving facilities occupied by the City unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without written permission by Owner.

B. Project-Site Information: Refer to the Soil Boring Logs for information related to type of soils, and ground water level at boring locations. The Soil Boring Logs will be made available. The Owner will not be responsible for interpretations or conclusions drawn from the data.

1. Before designing ERS, perform additional test borings and conduct other exploratory operations necessary to obtain accurate soils information for proper design of ERS. Cost of additional soils borings if needed are part of the contract price. There will be no additional compensations for additional soils borings.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During installation of ERS, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and

positions. Promptly notify the Owner if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2 PRODUCTS

2.01 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36, ASTM A 690, ASTM A 992, or ASTM A572.

C. Steel Sheet Piling: ASTM A 328, ASTM A 572, or ASTM A 690; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock

D. Wood Lagging: Lumber, mixed hardwood, required nominal rough thickness of minimum 3 inches.

E. Cast-in-Place Concrete: ACI 301, Concrete of compressive strength required for application.

F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed.

## PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during ERS operations.

1. Shore, support, and protect utilities encountered.

B. Install ERS to ensure minimum interference with roads, streets, walks and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the City and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate ERS clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Install sheet piles by push method. Monitor track vibrations during installation of piles with a Geotechnical Engineer present.

E. Monitor ERS daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

F. Promptly repair damages to adjacent facilities caused by installing ERS.

3.02 SOLDIER PILES AND LAGGING

A. Auger and install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

3.03 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 3 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.04 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved.

2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.05 REMOVAL AND REPAIRS

A. Leave ERS in place after construction and backfilling unless specifically directed otherwise by the City.

1. Remove excavation support and protection systems to a minimum depth of 36 inch below overlaying construction and abandon remainder
2. Repair or replace, as approved by ARCHITECT/ENGINEER, adjacent work damaged or displaced by removing excavation support and protection systems at no additional cost to the City.

**END OF SECTION 31 50 00**

# SECTION 32 12 16

# ASPHALT PAVING

## PART 4 - GENERAL

4.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

4.02 SUMMARY

A. Section Includes:

1. Asphalt pavement, sidewalks, and other asphalt pavement indicated.
2. Aggregate base course.
3. Double course bituminous concrete paving.

B. Related Requirements:

1. Section 31 22 14 “Earthwork”.
2. Section 32 13 13 “Concrete Paving”.
3. Section 32 17 23.13 “Painted Pavement Markings”.
4. Section 31 23 23 “Acceptance of Backfill, Topsoil, & CU Structural Soil”.

4.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
2. Review condition of subgrade and preparatory work.
3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
4. Review construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

4.04 ACTION SUBMITTALS

A. Product Data: Provide product data for each product specified.

B. Job-Mix Designs: For each job mix proposed.

1. Job-mix design documentation shall include the amount of RAP material, by percentage of total mix, to be utilized.
2. Job-mix design documentation shall clearly indicate source/origin of RAP material.

4.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For IDOT qualified manufacturer and installer.

B. Material Certificates: For each paving material, from manufacturer.

C. Material Test Reports: For each paving material and mix.

D. Field quality-control reports.

4.06 QUALITY ASSURANCE

A. Perform Work in accordance with Illinois Department of Transportation (IDOT) "Standard Specifications for Road and Bridge Construction".

1. Measurement and payment provisions and safety program submittals included in IDOT Standard Specifications do not apply to this Section.

B. Obtain materials from same source throughout.

C. Manufacturer Qualifications: Hot mix asphalt manufacturer shall have valid and current IDOT approvals for materials and work specified.

D. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

4.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement marking materials to project site in in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the CHA and authorities having jurisdiction.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

4.08 FIELD CONDITIONS

A. Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met. Temperatures are to be taken in the shade, away from exposed pavement and stone aggregate fill and other artificial heat sources.

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Slurry Coat: Comply with weather limitations in ASTM D3910.
3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Binder Course: Minimum surface temperature of 40 deg F and rising at time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

## PART 5 - PRODUCTS

5.01 MATERIALS

A. All fill materials to comply with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil."

B. Aggregate for Base Course: Complying with requirements of IDOT Standard Specifications, Section 311 for type B base course with gradation CA-6 crushed stone and Article 420.04; Material in accordance with Section 1003 and 1004.

C. Concrete Base: Complying with requirements of IDOT Standard Specifications, Section 353 & 354: Material in accordance with Section 1020.

D. Hot-mix Asphalt Surface Course: Complying with IL-9.5L, Ndes = 50 of the IDOT Standard Specifications.

E. Hot-Mix Asphalt Binder Course: Complying with IL-19L, Ndes = 50 of the IDOT Standard Specifications.

F. Street restoration City of Chicago Department of Transportation:

1. Residential:

    a. Hot-mix Asphalt Surface Course: Complying with IL-9.5L, Mix D, Ndes = 50 of the IDOT Standard Specifications.
    b. Hot-Mix Asphalt Binder Course: Complying with IL-19L, Mix D, Ndes = 50 of the IDOT Standard Specifications.

2. Primary Arterial

    a. Hot-mix Asphalt Surface Course: Complying with Polymerized Mix E, Ndes = 70 of the IDOT Standard Specifications.
    b. Hot-Mix Asphalt Binder Course: Complying with Polymerized, IL-4.5L, Ndes = 50 of the IDOT Standard Specifications.

3. Secondary Arterial and Collector

    a. Hot-mix Asphalt Surface Course: Complying with Mix D, Ndes = 70 of the IDOT Standard Specifications.
    b. Hot-Mix Asphalt Binder Course: Complying with Polymerized, IL-4.5L, Ndes = 50 of the IDOT Standard Specifications.

5.02 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

## PART 6 - EXECUTION

6.01 EXAMINATION

A. Verify that compacted subgrade is dry and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

C. Proceed only after unsatisfactory conditions have been corrected. Commencement of work in this section will be an indication of the acceptance of sub-grade and the Contractor will be held responsible for the satisfactory execution and results of the finished work.

D. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

6.02 AGGREGATE BASE COURSE

A. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Place and compact base course. Base course shall have a minimum Illinois Bearing Ratio (IBR) of 2.5 and comply with requirements of IDOT Standard Specifications, Section 301. Subgrade shall be proof-rolled in accordance with Section 31 22 14 – Earthwork.

C. Herbicide Treatment: Where required or as directed by Architect, apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

6.03 CONCRETE BASE COURSE

A. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

1. Refer to Section 32 13 13 “Concrete Paving” for concrete base requirements.

6.04 PREPARATION - PRIMER

A. Apply primer in accordance with manufacturer's instructions.

B. Apply primer on aggregate base or subbase at uniform rate of 0.25 - 0.50 gal/sq yd. Apply enough material to penetrate and seal, but not flood surface. Allow prime coat to cure before applying hot-mix asphalt paving.

C. Use clean sand to blot excess primer. Remove loose sand before pavement is placed and after volatiles have evaporated.

6.05 PREPARATION - TACK COAT

A. Apply tack coat in accordance with manufacturer's instructions.

B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of 0.1 gal/sq yd.

C. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces

D. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

E. Prohibit traffic across tack coat for period not less than that required by manufacturer.

6.06 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

A. Install Work in accordance with Illinois Department of Transportation (IDOT) "Standard Specifications for Road and Bridge Construction" Section 406 and 407.

B. Machine-place asphalt binder course within 24 hours of applying primer or tack coat.

C. Machine-place wearing course within two hours of placing binder course.

D. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course/wearing course in two lifts and thicknesses indicated.
2. Spread mix at minimum temperature of 250 deg F.
3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
5. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

    a. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

6. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

6.07 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course. Joints between successive days' work shall be constructed to ensure thorough and continuous bond between the newly and previously placed paving.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to the Asphalt Institute MS-22, "Construction of Hot-Mix Asphalt Pavements," for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within two percent (2%) of specified course density.

6.08 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D2041/D2041M, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Frames of subsurface structures:

1. Coat surfaces of new and existing frames with oil to prevent bond with asphalt paving.
2. Set cover rings to be flush with finish surface and surround with a ring of compacted asphaltic concrete to one inch below top of frame. Adjust as required to meet paving.
3. Provide temporary covers over openings until completion of rolling operations

H. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and sufficiently hardened, as determined by the Architect.

I. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

## 6.09 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge.

B. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.

C. Variation from True Elevation: Within 1/2 inch.

## 6.10 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform quality assurance tests and inspections as follows:

1. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D3549/D3549M.
2. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with specified tolerances.
3. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D979.

    a. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D2041/D2041M, and compacted according to job-mix specifications.
    b. In-place density of compacted pavement will be determined by testing core samples according to ASTM D1188 or ASTM D2726/D2726M.

        1) Take one core sample for every 1,000 square yards or less of installed pavement, with no fewer than three (3) core samples taken.
        2) Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D2950/D2950M and correlated with ASTM D1188 or ASTM D2726/D2726M.

4. Testing agency shall perform quality control testing per IDOT specifications and provide test reports.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace and/or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements

**END OF SECTION**

# SECTION 32 12 36

# ASPHALT SEALCOAT

## PART 7 - GENERAL

7.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

7.02 SUMMARY

A. Section Includes:

1. Asphalt Sealcoat.

B. Related Requirements:

1. Section 32 12 16 “Asphalt Paving”.
2. Section 32 17 23.13 “Painted Pavement Markings”.

7.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

1. Review the detailed requirements for the work of this section and to review the drawings and specifications for this work
2. Review condition of subgrade and preparatory work.
3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
4. Review construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

7.04 SUBMITTALS

A. Product Data: Provide product data for each product specified.

1. Include technical data and tested physical and performance properties.
2. Include cure time, based on mix design for the Project.

B. Samples: For each pavement marking product and for each color and texture specified; on rigid backing, 12-inches by 12-inches.

C. Qualification Data: For IDOT qualified manufacturer and installer.

1. Submit letter, signed by authorized representative of manufacturer, certifying the sealcoat products are acceptable for application intended and Project conditions.
2. Submit letter, signed by authorized representative of manufacturer, certifying the crack/joint sealant and sealcoat products are compatible with one another, based on recent testing by an independent testing agency.

## 7.05 QUALITY ASSURANCE

A. Perform Work in accordance with Illinois Department of Transportation (IDOT) "Standard Specifications for Road and Bridge Construction".

1. Measurement and payment provisions and safety program submittals included in IDOT Standard Specifications do not apply to this Section.

B. Manufacturer Qualifications: Products shall be provided from a manufacturer that specializes in the production of asphaltic materials, including sealcoats, with not less than five (5) years' experience.

C. Installer Qualifications: Engage an experienced Installer, who is authorized or approved in writing by the sealcoat product manufacturer(s), who has completed not less than three (3) sealcoat applications over the last five (5) years that were similar in material, design, and extent to that indicated for the project and which have resulted in installations with a record of successful in-service performance. Provide reference project names, locations, completion dates, names and telephone numbers of each project's Architect and CHA.

1. The Installer shall employ only skilled tradesmen who are thoroughly experienced with the materials and equipment to be used for the Work. The Installer shall maintain a full-time supervisor/foreman who is on the Site during the time the sealcoat work is in progress and who is experienced in installing sealcoat systems like type required for the Project.

D. Source Limitations: Obtain primary sealcoat materials from a single manufacturer. Provide other products as recommended by manufacturer of primary products for use with the sealcoat materials to be applied.

E. Regulatory Requirements: Comply with requirements of authorities having jurisdiction regarding application of, and disposal of excess, sealcoat materials, including stormwater pollution prevention requirements.

## 7.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original unopened containers, with manufacturer's original labels identifying manufacturer's name, product name, and directions for storing and handling.

B. Coordinate delivery of materials to minimize need for on-site storage and to avoid delays in the Work.

C. Store aggregate materials in a clean and dry location, under cover, protected from precipitation and direct sunlight, on elevated platforms where contamination can be avoided. Do not use aggregates that have become damp.

D. Store sealcoat materials within the temperature range required by the manufacturer.

7.07 FIELD CONDITIONS

A. Do not apply sealcoat materials if asphalt pavement is wet or excessively damp, if rain is imminent or expected before time required for adequate cure or 24 hours following application, whichever is greater.

B. Apply sealcoat materials to asphalt pavement surfaces that are not less than 50 deg F at time of application and anticipated to remain above 50 deg F for not less than 12 hours following time of application.

C. Apply sealcoat materials when ambient air temperature is 50 deg F and rising, but less than 85 deg F, and forecasted to remain above 50 deg F for not less than 48 hours following application.

D. Ambient air temperatures shall be measured in the shade, away from paved surfaces and other artificial sources of heat

7.08 WARRANTY

A. Special Warranty: Submit a written warranty, executed by the Contractor, Installer, and manufacturer of sealcoat products agreeing to remove and replace, or repair, areas of the sealcoat installations that develop defects in materials or workmanship within the specified warranty period. Defects include abnormal wear, beyond that attributed to anticipated traffic volume, flaking, chipping, loss of adhesion, and tracking to adjacent areas and surfaces.

1. Warranty Period: Two (2) years from date of Substantial Completion.

## PART 8 - PRODUCTS

8.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:

1. The Brewer Company; Milford, OH.
2. Neyra Industries, Inc.; Cincinnati, OH.

8.02 MATERIALS

A. Sealcoat: Polymer modified asphalt emulsion sealcoat complying with ASTM D2939 and ASTM D244; containing no coal tar; and containing less than 10 g/L volatile organic compounds (VOC's).

B. Aggregate: Water-washed and dried, angular silica sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof; free of clay, organic material, and other deleterious substances.

1. Gradation: Aggregate shall have a 40-70 AFS grain fineness number when tested in accordance with ASTM C136/C136M.

C. Water: Potable and free of harmful soluble salts; not less than 50 deg F.

D. Primer - Pavement: Rapid drying, water-based emulsion formulated for application over aged asphalt pavement, and that promotes adhesion of applied sealcoat. As recommended by sealcoat manufacturer for each application indicated and Project conditions, and compatible with applied sealcoat.

E. Primer - Oil Spot: Rapid drying, water-based emulsion formulated to seal and enhance adhesion over oil, grease, gasoline, and other fluid or chemical spots or stains. As recommended by sealcoat

F. Joint Sealant: ASTM D6690, Type II or III, hot-applied, single-component, polymer-modified bituminous sealant.

## PART 9 - EXECUTION

9.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with sealcoat manufacturer's requirements for conditions affecting sealcoat installation.

B. Verify that existing asphalt paving is dry and free of irregularities, defects, vegetation, and substances, including vehicular oils, fuels, or other fluids, that may adversely affect adhesion of sealcoat.

1. Defects include, but are not limited to, alligator cracking, rutting, depressions, ridging, and potholes.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Repairs to asphalt pavement shall be performed according to requirements in Section 32 12 16 “Asphalt Paving”.

9.02 PREPARATION

A. Apply primer in accordance with manufacturer's instructions.

B. Apply primer on aggregate base or subbase at uniform rate of 0.25 - 0.50 gal/sq yd. Apply enough material to penetrate and seal, but not flood surface. Allow prime coat to cure before applying hot-mix asphalt paving.

C. Use clean sand to blot excess primer. Remove loose sand before pavement is placed and after volatiles have evaporated.

9.03 PREPARATION - TACK COAT

A. Remove existing wheel stops, traffic calming devices, and ground-mounted signage. Store in protected location until reinstalled or replaced as indicated.

B. Provide surface-applied protection over surface catch basins, drains, manholes, and similar items that are not to receive sealcoat.

C. Protect adjacent curbs, fences, sidewalks, driveways, and other surfaces from application of primers and sealcoat.

D. Remove surface spots of oil, gas, grease, and other fluids - use household cleaner only as recommended by sealcoat manufacturer. Identify stained areas where oil spot primer is to be applied.

E. Crack and Joint Filling:

1. General: Comply with sealcoat manufacturer's written instructions regarding preparation, including routing, of cracks and joints in existing asphalt pavement.
2. Remove all vegetation, dirt, debris, and loose material from cracks and joints.
3. Ensure edges of cracks and joints are dry. Remove wetness from surfaces of cracks and joints.
4. Clean cracks and joints in existing hot-mix asphalt pavement. Remove existing joint sealant and rout cracks and joints as recommended by sealcoat manufacturer.
5. Cracks and joints less than 1/4-inch wide shall be routed to not less than 1/2-inch wide by 1/2-inch deep. Clean routed joints and cracks of debris and loose material.
6. Use hot-applied joint sealant to seal cracks and joints more than 1/4-inch wide, including routed cracks and joints. Fill flush with surface of existing pavement and remove excess

F. Immediately before placing primers and sealcoat materials, remove dust, dirt, and other loose foreign materials, mud and other lightly adhered materials, and debris from surface of asphalt pavement with air blower, power sweeper, or brooms. Water washing or flushing shall not be allowed unless approved in writing by primer manufacturer.

G. Asphalt pavement to receive sealcoat shall be prewetted with clean water as recommended by manufacturer.

9.04 PRIMER APPLICATION

A. Prepare and thoroughly mix oil spot and asphalt primers in accordance with manufacturer's written instructions. Mix during use/application as recommended by manufacturer.

B. Apply primers with equipment, and at application rates, recommended by manufacturer for the condition of the asphalt pavement, including staining, to be sealed.

C. Apply primer over hot-applied joint sealant as recommended by manufacturer.

## 9.05 SEALCOAT APPLICATION

A. Prepare and thoroughly mix pavement sealcoat in strict accordance with manufacturer's written instructions to achieve homogeneous mix and consistency recommended by manufacturer for condition of asphalt pavement.

1. Add water to sealcoat mix as recommended by manufacturer to achieve fluid consistency required to uniformly coat asphalt pavement at application rate recommended by manufacturer for the Project.
2. Add aggregate to sealcoat mix at rate recommended by manufacturer for the Project. Thoroughly mix aggregate into emulsion with power equipment to achieve homogeneous mixture with aggregate evenly distributed throughout, without clumping, and thoroughly coated.

B. Apply sealcoat mix in accordance with manufacturer's written instructions and as indicated. Mechanical equipment and applicators shall be capable of accurately and uniformly depositing/spreading the sealcoat mix over the asphalt pavement on a continuous basis. Mechanical equipment and agitators shall be capable of periodically, or continually, agitating the sealcoat mix, as recommended by the manufacturer, and as required to ensure proper suspension and uniformity of mix throughout application

1. Hand tools shall be used where space limitations prevent use of mechanical equipment or where neatly dressed detail work is required (e.g., along curbs). Care shall be taken to ensure areas of hand tool work are visually comparable to adjacent sealcoat applied by mechanical equipment.
2. Each coat of sealcoat mix shall be applied at minimum rate of 0.12 gallons / sq. yard.
3. Two coats of sealcoat shall be applied to all asphalt pavement areas at application rates indicated and as recommended by manufacturer for the Project and anticipated amount of traffic.
4. Three coats of sealcoat shall be applied where indicated, as recommended by manufacturer, and/or as requested by Architect or CHA’s Designated Representative in areas where high traffic volumes are anticipated.
5. Allow initial and intermediate coat (when required) to thoroughly dry (tack free and resistant to scuffing) prior to application of subsequent coat of sealcoat.
6. Sealcoat shall be applied uniformly, free of holidays and pinholes.

## 9.06 FIELD QUALITY CONTROL

A. Engage a technical site representative of the sealcoat manufacturer to inspect substrate conditions; surface preparation; and application of asphalt sealcoat materials.

1. Technical site representative shall measure thickness with pin tester or other suitable device at least once for every 5,000 sq. ft. and include measurements in written report.

B. Remove and replace or install additional sealcoat materials, as recommended by manufacturer's technical site representative, where test results or measurements indicate that it does not comply with specified requirements.

9.07 PROTECTION

A. Prohibit pedestrian and vehicular traffic from seal coated asphalt pavement for not less than 48 hours after sealcoat application is completed.

B. Before opening seal coated asphalt pavement areas to traffic, examine all areas over which sealcoat materials were applied, with Installer, Architect, CHA's Designated Representative, and manufacturer's technical field representative present, to verify that sealcoat materials are thoroughly dry (tack free and resistant to scuffing) and free from tracking to adjacent areas.

C. Protect pavement markings from damage and wear during remainder of construction period.

9.08 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction to the satisfaction of the Architect and CHA's Designated Representative.

**END OF SECTION**

# SECTION 32 13 13

# CONCRETE PAVING

## PART 10 - GENERAL.

10.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

10.02 SUMMARY

A. Section Includes:

1. Concrete Paving.
2. Sidewalks.
3. Integral curbs and gutters.
4. Other concrete paving indicated.

B. Related Requirements:

1. Section 31 22 14 “Earthwork”.
2. Section 31 23 23 “Acceptance of Backfill, Topsoil, & CU Structural Soil”.
3. Section 32 17 23.13 “Painted Pavement Markings”.

10.03 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

10.04 SUBMITTALS

A. Product Data: Provide data on joint filler, admixtures, and curing compound as applicable.

B. Product Data: ADA Detectible Waring Title

C. Laboratory Test Reports: Submit 2 copies of laboratory test reports to concrete materials and mix design tests.

D. Delivery Tickets: Submit copies of delivery tickets for each load of concrete delivered to the site.

E. Environmental Submittals: Imported subbase materials shall be in conformance with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil."

10.05 QUALITY ASSURANCE

A. Perform Work in accordance with Illinois Department of Transportation (IDOT) "Standard Specifications for Road and Bridge Construction" and the city of Chicago.

1. Measurement and payment provisions and safety program submittals included in IDOT Standard Specifications do not apply to this Section.

B. Obtain materials from same source throughout.

C. Concrete Testing: Engage an independent testing laboratory to perform initial field quality control testing.

1. Materials and installed work may require testing and retesting at any time during the progress of the Work. Always allow free access to material stockpiles and facilities. Retesting of rejected materials and installed Work shall be done at the Contractor's expense.
2. Three concrete test cylinders shall be taken for every 75 cu. yds. or less of each class of concrete placed each day.
3. One additional test cylinder shall be taken during cold weather and be cured on site under same conditions as concrete it represents.
4. One slump test shall be taken for each set of test cylinders taken.

10.06 MOCK-UP

A. Provide Concrete Paving mock-up inclusive of a handicapped curb ramp (if applicable), 15 feet long by 5 feet wide, illustrating proposed color, surface finish of both the walk and textured ramp surface, reinforcement, control and expansion joints, sealant, and workmanship.

B. Locate where directed by Architect.

C. Do not start concrete site work until the Architect has given written approval of all components of the sample panel.

D. This sample panel will be used as a standard of comparison for all site concrete constructed of same materials.

E. Mock-up may remain as part of the Work. Protect to maintain the standard for comparison throughout the duration of concrete pavement work.

## PART 11 - PRODUCTS

11.01 FORM MATERIALS

A. Comply with IDOT Specifications, Article 1103.05.

11.02 REINFORCEMENT

A. Reinforcing Steel: Comply with IDOT Specifications, Article 1006.10.

B. Steel Welded Wire Reinforcement: Comply with IDOT Specifications, Article 1006.10.

C. Tie wire: Annealed steel, minimum 16-gauge size.

D. Dowels: Comply with IDOT Specifications, Article 1006.11.

E. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished.

11.03 CONCRETE MATERIALS

A. Comply with IDOT Specifications, Article 1020.

B. Obtain cementitious materials from same source throughout.

C. Air-Entraining Admixtures: ASTM C260/C260M.

D. Chemical Admixtures: ASTM C494/C494M, Type A - Water Reducing and Type C - Accelerating.

1. Do not use chemicals that will result in soluble chloride ions more than 0.1 percent by weight of cement.

11.04 ACCESSORIES

A. Curing Compound: Comply with IDOT Specifications, Article 718.04; ASTM C309, Type 1, Class A.

B. Liquid Surface Sealer: ASTM D3405.

C. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2-inch-deep sealant pocket after removal.

1. Material: ASTM D1751, cellulose fiber.

11.05 CONCRETE MIX DESIGN

A. Comply with IDOT Specifications, Article 1020. Also mix in accordance with Part 3.03.

B. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

1. Use accelerating admixtures in cold weather only with prior written approval from Architect. Use of admixtures will not relax cold weather placement requirements.
2. Add air entraining agent to concrete mix for concrete work subject to freeze/thaw cycling and exposed to exterior.
3.

C. Concrete Properties:

1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days: 3500 psi.

11.06 MIXING

A. Ready-Mixed Concrete: Comply with Sections 420, 1020, and 1103 of IDOT SSRBC and all other related sections of IDOT SSRBC and SSRSP.

11.07 DETECTABLE WARNING MATERIALS

A. Detectable Warning Materials: Detectable warning shall be cast iron panels constructed of gray iron meeting the requirements of ASTM A48, Class 35B.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following.

a. East Jordan Iron Works Company
b. Neenah Foundry Company
c. Deeter Foundry

2. Size: Refer to plans for location of detectable warning devices; devices shall be a depth of 24-inches aligning to the path of travel.

**PART 12 - EXECUTION**

12.01 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

C. Proceed only after unsatisfactory conditions have been corrected. Commencement of work in this section will be an indication of the acceptance of sub-grade and the Contractor will be held responsible for the satisfactory execution and results of the finished work.

12.02 SUBBASE

A. Comply with IDOT Specifications, Article 420.04.

B. Proof roll areas under drives and parking areas.

C. Provide additional fill for soft spots and hollows.

D. Level and Compact subgrade, to receive granular base for concrete work, to 95% Modified Proctor Density.

12.03 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Notify Architect minimum 24 hours prior to commencement of concreting operations.

12.04 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

12.05 REINFORCEMENT

A. Place reinforcement at mid-height of slabs-on-grade except where otherwise indicated.

B. Interrupt reinforcement at contraction and expansion joints.

C. Place dowels to achieve pavement and curb alignment as detailed.

D. Provide doweled joints 12 inch on center, except where otherwise indicated, at interruptions with one end of dowel set in capped sleeve to allow longitudinal movement.

12.06 PLACING CONCRETE

A. Comply with IDOT Specifications, Articles 420 and 606.

B. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.

C. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

12.07 JOINTS

A. Align curb, gutter, and sidewalk joints.

B. Place 3/8-inch-wide expansion joints at 20-foot intervals, except where otherwise shown, and to separate paving from vertical surfaces and other components and in pattern indicated.

C. Provide scored joints.

1. At 5 feet intervals except where otherwise shown.

12.08 CURING

A. Curing and protection shall be as outlined in IDOT Specifications, Articles 1020.13 and 1022. Color lithochromatic color wax matching the colored concrete as manufactured by L.M. Schofield Company or approved equal and applied in accordance with the manufacturer's written instructions; or white pigmented curing compound as outlined in IDOT Specification, Article 1022.01.c are the preferred curing methods. White-opaque polyethylene film shall not be accepted as a curing method.

12.09 FINISHING

A. Area Paving: Wood float.

B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4-inch radius.

C. Curbs and Gutters: Light broom, texture parallel to pavement direction.

D. Handicap curb ramps: The detectable warning used shall be from the Chicago Department of Transportation list of approved detectable warning products (available on the City of Chicago website). It is not acceptable to install two different detectable warning products adjacent to one another at any location. The detectable warning must cover full width of the ramp excluding side flares for a minimum unobstructed depth of 24". The detectable warning shall comply with ADA Standards and the pattern to be continuous throughout the ramp width and side flares at each location.

E. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

12.10 TOLERANCES

A. Formed concrete having any dimension smaller or greater than required, and outside the specified tolerance limits, will be considered deficient in strength and subject to additional testing as herein specified.

B. Formed concrete having any dimension greater than required will be rejected if the appearance or function of the structure is adversely affected, or if the larger dimensions interfere with other construction. Repair, or remove and replace rejected concrete as required to meet the construction conditions. When permitted, accomplish the removal of excessive material in a manner to maintain the strength of the section without affecting function and appearance.

12.11 FIELD QUALITY CONTROL

A. Perform field quality control tests as follows:

1. Provide free access to concrete operations at project site and cooperate with appointed firm.
2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
3. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
4. Retesting of rejected materials and installed Work shall be done at the Contractor's expense.

B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold, and cure three concrete test cylinders. Obtain test samples for every 75-cu yd or less of each class of concrete placed.

1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
2. Perform one slump test for each set of test cylinders taken.

C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

D. Defective Work: Concrete work which does not conform to the specified requirements, including strength, tolerances, and finishes, shall be corrected at the Contractor's expense, without extension of time, therefore. The Contractor shall also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

12.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

**END OF SECTION**

# SECTION 32 14 13 – PRECAST CONCRETE UNIT PAVER

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes the following:

1. Concrete Pavers
2. Joint Sand
3. Setting Bed Sand
4. Base Aggregate
5. Subbase Aggregate

### 1.02 REFERENCES

Note: Design street, industrial, port and airport pavement thicknesses in consultation with a qualified civil engineer, in accordance with established flexible pavement design procedures, LOCKPAVE® software, and in accordance with Interlocking Concrete Pavement Institute Technical Bulletins. Sample construction detail drawings are available from Unilock®. This specification may require modifications.

A. ASTM International, latest edition:

1. C 33, Standard Specification for Concrete Aggregates.
2. C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
3. C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
4. C 144 Standard Specifications for Aggregate for Masonry Mortar.
5. D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
6. C 936, Standard Specification for Solid Concrete Interlocking Paving Units.
7. C 979, Standard Specification for Pigments for Integrally Colored Concrete.

8. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.

9. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.

10. C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units

11. D 2940 Graded Aggregate Material for Bases or Subbases for Highways or Airports.

12. D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

13. D 4533, Standard Test Method for Index Trapezoidal Tearing Strength of Geotextiles

14. D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products

15. D 4491, Standard Test Method for Water Permeability of Geotextiles by Permittivity

16. D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile

Note: In order to determine the latest version of the listed specifications and standards, please consult the ASTM web page (www.astm.com)

B. U.S. Green Building Council Leadership in Energy and Environmental Design (LEED)

1. Building Design + Construction, latest edition

1.03 SUBMITTALS

A. Concrete Pavers:

1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon project completion.

2. Accepted samples become the standard of acceptance for the product produced.

3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.

4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

B. Joint and Setting Bed Sand:

1. Provide three representative one pound samples in containers of Joint Sand materials.

2. Provide three representative one pound samples in containers of Setting Bed Sand materials.

3. Test results from an independent testing laboratory for sieve analysis per ASTM C 136 conforming to the grading requirements of ASTM C 144.

C. Polymeric Joint Sand:

1. Test results from an independent testing laboratory for sieve analysis per ASTM C 136 conforming to the grading requirements of ASTM C 144.

2. Samples for Initial Selection: Provide three representative samples in containers of Polymeric Joint Sand material, cured and dried, for color selection.

3. Samples for Verification: Provide three one pound samples in containers of Polymeric Joint Sand.

D. Base and Subbase Aggregate:

1. Test results from an independent testing laboratory for sieve analysis per ASTM C 136.

E. Paving Installation Contractor:

1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

1.04 QUALITY ASSURANCE

A. Utilize a Manufacturer having at least ten years of experience manufacturing concrete pavers on projects of similar nature or project size.

B: Source Limitations:

1. Obtain Concrete Pavers from one source location with the resources to provide products of consistent quality in appearance and physical properties.

2. Obtain Joint and Setting Bed Sands from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.

3. Obtain Polymeric Joint Sand from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.

C. Paving Contractor Qualifications:

1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.

D. Mockups:

1. Install a 5 ft x 5 ft paver area per each paving pattern.

2. Use this area to determine surcharge of the Setting Bed Sand layer, joint sizes, lines, laying pattern(s) and levelness. This area will serve as the standard by which the workmanship will be judged.

3. Subject to acceptance by owner, mock-up may be retained as part of finished work.

4. If mock-up is not retained, remove and dispose legally.

1.05 DELIVERY, STORAGE & HANDLING

A. In accordance with Conditions of the Contract and Division 1 Product Requirement Section.

B. Deliver Concrete Pavers in manufacturer's original, unopened and undamaged container packaging with identification labels intact.

1. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.

2. Deliver Concrete Pavers to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.

3. Unload Concrete Pavers at job site in such a manner that no damage occurs to the product or adjacent surfaces.

C. Store and protect materials free from mud, dirt and other foreign materials.

D. Prevent Joint and Setting Bed Sand from exposure to rainfall or removal by wind with secure, waterproof covering.

E. Store Polymeric Joint Sand on elevated platforms, under a cover and/or in a dry location.

1.06 PROJECT/SITE CONDITIONS

A. Environmental Requirements:

1. Install Concrete Pavers only on unfrozen and dry Setting Bed Sand.

2. Install Setting Bed Sand only on unfrozen and dry Base or Subbase Aggregate materials.

3. Install Base or Subbase Aggregates only over unfrozen subgrade.

4. Install Setting Bed Sand or Concrete Pavers when no heavy rain or snowfall are forecast within 24 hours.

B. Weather Limitations for Polymeric Jointing Sand:

1. Install Polymeric Joint Sand only when ambient temperature is above 40°F (5°C), under dry conditions with no rain forecast for 24 hours and when surface of pavement is completely dry.

1.07 CONCRETE PAVER OVERAGE AND ATTIC STOCK

A. Provide a minimum of 5% additional material for overage to be used during construction.

B. Contractor to provide 100 square feet of each product and size used to owner for maintenance and repair. Furnish Pavers from the same production run as installed materials.

C. Manufacture to supply maintenance and reinstatement manuals for Concrete Paver units.

PART 2 PRODUCTS

2.01 CONCRETE PAVERS

A. Basis-of-Design Product: The Concrete Paver shapes are based on:

1. Unilock: (Select product or products being used)

a. Promenade Plank

2. As manufactured by:

Unilock Midwest

301 E. Sullivan Road

City, State and Zip

Contact: Brad Swanson (630) 742-4168, brad.swanson@unilock.com

3. The specified products establish minimum requirements that substitutions must meet to be considered acceptable.

a. To obtain acceptance of unspecified products, submit written requests at least 7 working days before the Bid Date.

B. Product requirements:

1. Concrete Paver Type 1: Promenade Premier

a. Finish: Smooth (Premier) – this is a face mix finish.

b. Color: Opal

c. Edge: Rolled

d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch..

1. 10 cm (4 in) x 30 cm (12 in) x 10 cm (4 in)

2. 10 cm (4 in) x 40 cm (16 in) x 10 cm (4 in)

3. 20 cm (8 in) x 60 cm (24 in) x 10 cm (4 in)

Note: Imperial dimensions are nominal equivalents to the metric dimensions.

e. LEED: HPD 2.1 or latest transparency data

2. Concrete Paver Type 2: Promenade IL Campo

a. Finish: Brushed (IL Campo) – this is a face mix finish.

b. Color: Granite

c. Edge: Rolled

d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch.

1. 10 cm (4 in) x 30 cm (12 in) x 10 cm (4 in)

2. 20 cm (8 in) x 60 cm (24 in) x 10 cm (4 in)

Note: Imperial dimensions are nominal equivalents to the metric dimensions.

e. LEED: HPD 2.1 or latest transparency data

3. Concrete Paver Type 3: Promenade Series

a. Finish: Exposed Granite (Series 3000) – this is a face mix finish.

b. Color: Black Granite

c. Edge: Rolled

d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch.

1. 10 cm (4 in) x 30 cm (12 in) x 10 cm (4 in)

2. 20 cm (8 in) x 60 cm (24 in) x 10 cm (4 in)

Note: Imperial dimensions are nominal equivalents to the metric dimensions.

e. LEED: HPD 2.1 or latest transparency data

C. Provide pavers meeting the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence is not a cause for rejection.

1. Average compressive strength 8000 psi (55MPa) with no individual unit under 7,200 psi (50 MPa).

2. Average absorption of 5% with no unit greater than 7% when tested according to ASTM C 140.
3. Conforming to ASTM C 1645 when tested for freeze-thaw requirements.
4. Height tolerances +/- 3.2 mm (1/8 in).

D. Accept only pigments in concrete pavers conforming to ASTM C 979.

Note: ACI Report No. 212.3R provides guidance on the use of pigments.

E. Maximum allowable breakage of product is 5%.

2.02 JOINT SAND

A. Provide natural Joint Sand as follows:

1. Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.

2. Do not use limestone screenings, stone dust, or sand for the Joint Sand material that does not conform to conform to the grading requirements of ASTM C 33.

4. Utilize sands that are as hard as practically available where concrete pavers are subject to vehicular traffic.

5. Gradation as shown in Table 1 below:

TABLE 1 – JOINT SAND

GRADATION REQUIREMENTS FOR JOINT SAND

| ASTM C 144 | | |
|---|---|---|
| Sieve Size | Natural Sand<br>Percent Passing | Manufactured Sand<br>Percent Passing |
| No. 4 (4.75 mm) | 100 | 100 |
| No. 8 (2.36 mm) | 95 to 100 | 95 to 100 |
| No. 16 (1.18 mm) | 70 to 100 | 70 to 100 |
| No. 30 (0.600 mm) | 40 to 75 | 40 to 75 |

| | | |
|---|---|---|
| No. 50 (0.300 mm) | 10 to 30 | 20 to 40 |
| No. 100 (0.150 mm) | 2 to 15 | 10 to 25 |
| No. 200 (0.075) | 0 to 1 | 0 to 10 |

2.03 POLYMERIC JOINT SAND

A. Provide Polymeric Joint Sand as manufactured by:

1. Alliance Gator G2

a. Product Type: Dry mix, contains polymeric binding agent, activated with water.

b. Color: (Slate Grey or Black Diamond)

2. Unicare HP Polymeric Max Sand

a. Product Type: Dry mix, contains polymeric binding agent, activated with water.

b. Color: (Insert color Grey, Tan or custom)

B. Provide Polymeric Joint Sand meeting the minimum material and physical properties as follows:

1. Compression Strength: proven resistance to compression of 550 PSI after drying for 7 days under controlled conditions (73°F (23°C) at 50% humidity).

a. Test sand sample shape: cylinder (2” (5 cm) dia. X 4” (10 cm) high).

2. Gradation as shown Table 1 above.

2.04 SETTING BED SAND

A. Provide Setting Bed Sand as follows:

1. Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.

2. Do not use limestone screenings, stone dust, or sand material that does not conform to conform to the grading requirements of ASTM C 33.

3. Do not use mason sand or sand conforming to ASTM C 144.

4. Utilize sands that are as hard as practically available where concrete pavers are subject to vehicular traffic.

5. Conform to the grading requirements of ASTM C 33 with modifications as shown in Table 2 below:

TABLE 2 – SETTING BED SAND

GRADATION REQUIREMENTS FOR SETTING BED SAND

| ASTM C 33 | |
|---|---|
| Sieve Size | Percent Passing |
| 3/8 in (9.5 mm) | 100 |
| No. 4 (4.75 mm) | 95 to 100 |
| No. 8 (2.36 mm) | 85 to 100 |
| No. 16 (1.18 mm) | 50 to 85 |
| No. 30 (0.600 mm) | 25 to 60 |
| No. 50 (0.300 mm) | 10 to 30 |
| No. 100 (0.150 mm) | 2 to 10 |
| No. 200 (0.075) | 0 to 1 |

Note: Coarser sand than that specified in Table 1 above may be used for joint sand including C 33 material as shown in Table 2. Use material where the largest sieve size easily enters the smallest joints. For example, if the smallest paver joints are 2 mm wide, use sand 2 mm and smaller in particle size. If C 33 sand is used for joint sand, extra effort may be required in sweeping material and compacting the pavers in order to completely fill the joints.

2.05 BASE AGGREGATE

A. Provide Base Aggregate materials conforming to ASTM D 2940 and gradation requirements as presented in Table 3.

TABLE 3

BASE AGGREGATE

GRADATION REQUIREMENTS

| ASTM D 2940 | |
|---|---|
| Sieve Size | Percent Passing |
| 2 in (50 mm) | 100 |
| 1-1/2 in (37.5 mm) | 95 to 100 |
| 3/4 in (19 mm) | 70 to 92 |
| 3/8 in (9.5 mm) | 50 to 70 |
| No. 4 (4.75 mm) | 35 to 55 |
| No. 30 (600 µm) | 12 to 25 |
| No. 200 (75 µm) | 0 to 8* |

* In order to prevent damage by frost heaving, it may be necessary to limit the percentages of material passing the No. 200 sieve to less than shown in the tables.

2.06 SUBBASE (Add information below or reference sections in the contract documents with this information)

A. Provide Subbase Aggregate as designed per the structure engineer.

B. Insert gradation requirements here.

2.07 GEOTEXTILE

A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:

1. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

2. Grab Tensile Strength: ASTM D 4632: 115 lbs.

3. Grab Tensile Elongation: ASTM D 4632: 50%

4. Trapezoidal Tear: ASTM D 4533: 50 lbs.

5. Puncture: ASTM D 4833: 65 lbs.

6. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve

7. Permittivity: ASTM D 4491: 2.0 sec -1

8. Flow Rate: ASTM D 4491: 140 gal/min/s.f.

B. As supplied by Unilock (add location, address, City, State and Zip)

Contact: Brad Swanson or your local Territory Manager

1. Carthage Mills – FX-40HS

2. U.S. Fabrics – US 115NW

3. Mirafi – 140N

2.08 EDGE RESTRAINTS

A. Concrete Edge Restraint as indicated.

2.09 ACCESSORIES

A. [Cleaners] [Sealers] [Joint sand stabilizers]

1. Supplier: Unilock (add location, address, City, State and Zip)

Contact Brad Swanson or your local Territory Manager

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine areas indicated to receive paving for compliance with requirements for installation tolerances and other conditions affecting performance for the following items before placing the Concrete Pavers.

1. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.

2. Verify that Geotextiles, if applicable, have been placed according to drawings and specifications.

3. Verify that the Base and Subbase Aggregate materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.
4. Provide written density test results for soil subgrade, Base and Subbase Aggregate materials to the Owner, General Contractor and paver installation subcontractor.

5. Verify location, type, and elevations of edge restraints, concrete curbing, concrete collars around utility structures, and drainage inlets.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of Bedding Sand and Concrete Paver installation signifies acceptance of Base and edge restraints.

### 3.02 PREPARATION

A. Verify that the subgrade soil is free from standing water.

B. Stockpile Setting Bed Sand, Joint Sand, Base and Subbase Aggregate materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.

C. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Geotextile and Subbase Aggregate materials.

D. Keep area where pavement is to be constructed free from sediment during entire job. Remove and replace all Geotextile, Joint Sand, Setting Bed Sand, Base and Subbase Aggregate materials contaminated with sediment with clean materials.

E. Complete all subdrainage of underground services within the pavement area in conjunction with subgrade preparation and before the commencement of Base or Subbase Aggregate construction.

F. Prevent to damage underdrain pipes, overflow pipes, observation wells, or inlets and other drainage appurtenances during installation. Report all damage immediately.

G. Compact soil subgrade uniformly to at least 95 percent of Standard Proctor Density per ASTM D 698 for pedestrian areas. Compact soil subgrade uniformly to at least 98 percent Modified Proctor per ASTM D 1557 for vehicular areas. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils.

H. Backfill all service trenches within the pavement area to the sub- grade level with approved material placed in uniform lifts not exceeding 4 in. (100 mm) loose thickness. Compact each lift to at least 100 percent Standard Proctor Density as specified in ASTM D 698.

I. Trim the subgrade to within 0 to ½ in. (0 to 13mm) of the specified grades. Do not deviate the surface of the prepared subgrade by more than 3/8 in. (10mm) from the bottom edge of a 39 in. (1m) straight edge laid in any direction.

J. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting and replace with compacted backfill or fill as directed.

K. Do not proceed with further pavement construction, under any circumstances, until the subgrade has been inspected by the Architect/Engineer.

Note: Base compaction of the subgrade soil on the recommendations of the Design Engineer. Request the Architect/Engineer to inspect subgrade preparations, elevations and conduct density tests for conformance to specifications.

3.03 INSTALLATION

A. EDGE RESTRAINTS

1. Provide concrete edge restraints as indicated.

a. Install job-built concrete edge restraints to comply with requirements in Division 3 Section "Cast-in-Place Concrete."

b. Provide concrete edge restraint along the perimeter of all paving as indicated. Install the face of the concrete edge restraint, where it abuts pavers vertical down to the subbase.

c. Construct concrete edge restraint to dimensions and level specified and support on a compacted subbase not less than 6 in (150 mm) thick.

B. GEOTEXTILES

1. Provide separation geotextile on bottom and sides of prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.

2. Overlap ends and edges a minimum of 18 in. (450 mm) in the direction of drainage.

C. BASE AND SUBBASE AGGREGATE

1. Provide the Subbase Aggregate in uniform lifts not exceeding 6 in., (150 mm) loose thickness and compact to at least 100 percent Standard Proctor Density as per ASTM D 698.

2. Compact the Subbase Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.

3. Tolerance: Do not exceed the specified surface grade of the compacted Subbase Aggregate material more than ±3/4 in. (20 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
4. Provide the Base Aggregate material in uniform lifts not exceeding 6 in. (150 mm) over the compacted Subbase Aggregate (or Subgrade) material and compact to at least 100 percent Standard Proctor Density as per ASTM D 698.
5. Compact the Base Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
6. Tolerance: Do not exceed the specified surface grade of the compacted Base Aggregate material more than ±3/8 in. (10 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
7. Compact and grade the upper surface of the base sufficiently to prevent infiltration of the bedding sand into the base both during construction and throughout its service life. Blend segregated areas of the granular base by the application of crushed fines that have been watered and compacted into the surface.

D. SETTING BED SAND

1. Provide, spread and screed Setting Bed Sand evenly over the compacted Base Aggregate course.

   a. Protect screeded Setting Bed Sand from being disturbed by either pedestrian or vehicular traffic.

   b. Screed only the area which can be covered by pavers in one day.

   c. Do not use Setting Bed Sand material to fill depressions in the base surface.

2. Keep moisture content constant and density loose and constant until Concrete Pavers are set and compacted.

3. Screed Setting Bed Sand using either an approved mechanical spreader (e.g.: an asphalt paver) or by the use of screed rails and boards. Maintain in a loose condition slightly ahead of the paving units and fully protect against incidental compaction following screeding. Loosen compacted sand by rain or screeded sand left overnight before further paving units are placed.

4. Inspect the Setting Bed Sand course prior to commencing the placement of the Concrete Pavers. Acceptance of the Setting Bed Sand occurs with the initiation of Concrete Paver placement.

E. CONCRETE PAVERS

1. Replace Concrete Pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

2. Mix Concrete Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures. (Color variation occurs with all concrete products. This phenomenon is influenced by a variety of factors, e.g. moisture content, curing conditions, different aggregates and, most commonly, from different production runs. By installing from a minimum of three (3) bundles simultaneously, variation in color is dispersed and blended throughout the project).

3. Exercise care in handling face mix concrete pavers to prevent surfaces from contacting backs or edges of other units.

4. Provide Concrete Pavers using laying pattern as indicated. Adjust laying pattern at pavement edges such that cutting of edge pavers is minimized. Cut

all pavers exposed to vehicular tires no smaller than one-third of a whole paver.

5. Use string lines or chalk lines on Setting Bed Sand to hold all pattern lines true.

6. Set paver surface elevation a minimum of 3 mm (1/8 inch) to a maximum of 6 mm (1/4 inch) above adjacent drainage inlets, concrete collars or channels (provided the change in slope does not impede or alter the drainage or direction of flow).

7. Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.

    a. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

8. Provide space between paver units of 1/32 in. (1 mm) wide to achieve straight bond lines.

9. Prevent joint (bond) lines from shifting more than ±1/2 in. (±13 mm) over 50 ft. (15 m) from string lines.

10. Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.

11. Cut Concrete Pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

12. Prevent all traffic on installed Concrete Pavers until Joint Sand has been vibrated into joints. Keep skid steer and forklift equipment off newly laid Concrete Pavers that have not received initial compaction and Joint Sand material.

13. Vibrate Concrete Pavers into leveling course with a low-amplitude plate vibrator capable of a to 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:

    a. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.

b. Compact installed Concrete Pavers to within 6 feet (2 meters) of the laying face before ending each day's work. Cover Concrete Pavers that have not been compacted and leveling course on which pavers have not been placed, with nonstaining plastic sheets to prevent Setting Bed Sand from becoming disturbed.

14. Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.

15. Remove any cracked or structurally damaged Concrete Pavers and replace with new units prior to installing Joint Sand material.

F. JOINT SAND

1. Provide, spread and sweep dry Joint Sand into joints immediately after vibrating pavers into Setting Bed Sand course until full. Vibrate pavers and add Joint Sand material until joints are completely filled, then remove excess material. This will require at least 4 passes with a plate compactor.

2. Leave all work to within 3 ft. (1 m) of the laying face fully compacted with sand-filled joints at the completion of each day.

3. Remove excess Joint Sand broom clean from surface when installation is complete.

4. Polymeric Joint Sand

a. Install Polymeric Joint Sand per manufacturers recommended instructions.

3.04 FIELD QUALITY CONTROL

A. Verify final elevations for conformance to the drawings after sweeping the surface clean.

1. Prevent final Concrete Paver finished grade elevations from deviating more than ±3/8 in. (±10 mm) under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.

B. Lippage: Paver-to-Paver Lippage:

1. No greater than 3 mm (1/8 inch) difference in height between adjacent pavers.

3.05 REPAIRING, CLEANING AND SEALING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean.

1. Clean Concrete Pavers in accordance with the manufacturer's written recommendations.

3.06 PROTECTION

A. Protect completed work from damage due to subsequent construction activity on the site.

END OF SECTION

**SECTION 32 17 23.13**

**PAINTED PAVEMENT MARKINGS**

## PART 13 - GENERAL

13.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

13.02 SUMMARY

A. Section Includes:

1. Parking lot markings, including parking bays, crosswalks, arrows, accessibility symbols, and curb markings.
2. "No Parking" curb painting.
3. Play areas and basketball courts.

B. Related Requirements:

1. Section 32 12 16 "Asphalt Paving".
2. Section 32 12 36 "Asphalt Sealcoat".
3. Section 32 13 13 "Concrete Paving".
4. Section 31 14 13 "Precast Concrete Unit Paving".

13.03 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

B. Shop Drawings: Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

13.04 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

13.05 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

**PART 14 - PRODUCTS**

14.01 MATERIALS

A. Line and Zone Marking Paint: Latex, waterborne emulsion, lead, and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.

B. Colors: As indicated below. For items not indicated below, provide color(s) as indicated on the Drawings or, if not indicated, as required by the Architect.

1. Standard Parking Stalls: White.
2. Accessible Parking Stalls and Access Aisles: Yellow.
3. International Symbol of Accessibility: Blue field with international symbol of accessibility either yellow or white.
4. Stop Lines and Other Traffic Symbols: White.
5. Play and basketball court: White

C. Paint for Obliterating Existing Markings: FS TT-P-1952; black for bituminous pavements, gray for Portland cement pavements.

D. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

**PART 15 - EXECUTION**

15.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared and cured.

B. Proceed only after unsatisfactory conditions have been corrected. Commencement of work in this section will be an indication of the acceptance of sub-grade and the Contractor will be held responsible for the satisfactory execution and results of the finished work.

15.02 PREPARATION

A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

B. Clean surfaces thoroughly prior to installation.

1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.

C. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

D. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

E. Do not apply pavement-marking paint until layout of striping, directional arrows and other special designations, colors, and placement as indicated on Drawings have been verified with Architect.

## 15.03 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.

1. Apply paint in one coat only.
2. Wet Film Thickness: 0.016-inch, minimum.
3. Width Tolerance: +/-1/8 inch.

G. Parking Lots: Apply parking space lines, entrance, and exit arrows, painted curbs, and other markings indicated on drawings.

1. Mark the International Symbol of Accessibility at indicated parking spaces.
2. Hand application by pneumatic spray is acceptable.

H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

**END OF SECTION**

# 32 31 19 - DECORATIVE METAL FENCES AND GATES

## PART 1 – GENERAL

### 1.1 DESCRIPTION

.1 General Requirements are part of this specification and shall apply as if repeated here.

.2 Work includes:

.1 Exterior Decorative Metal Panels

.3 Related work not included:

.1 Substrates

### 1.2 COORDINATION

.1 Coordinate installation of anchorages for decorative metal panels. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

.2 Coordinate installation of decorative formed metal with adjacent construction to ensure that wall assemblies, flashings, trim, and joint sealants, are protected against damage from the effects of weather, age, corrosion, and other causes of deterioration.

### 1.3 DESIGN REQUIREMENTS

.1 Panel removal: System shall be non-progressive, allowing removal of any individual panel without necessitating removal of adjacent work.

.2 Structural movement: Accommodate movement of supporting structural framing and without causing bowing, buckling, delamination, oil canning, excessive stress on fasteners, or any other detrimental effects.

.3 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

.1 Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces

.4 Maximum deviation from vertical and horizontal alignment of erected panels: 0.25" in 20' 0"

.5 Maximum deviation from panel flatness shall be 0.10" in 60" panel in any direction for assembled units (non-accumulative).

1.4 SAMPLES

.1 Submit samples in accordance with Division 1 Section, Submittals.

.2 Submit duplicate, minimum 3-½" x 3-½" samples of each color selected.

1.5 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Division 1 Section, Submittals

.2 Indicate elevations, profiles, dimensions and thickness of panels.

.3 Indicate location and detail of joints including joints necessary to accommodate thermal movement.

.4 Indicate attachment clips, joint extrusion system and installation details.

.5 Show fastening and anchoring details.

.6 Coordination Drawings: For decorative formed metal elements that house items specified in other Sections. Show dimensions of housed items, including locations of housing penetrations and attachments, and necessary clearances

.7 Drawings for railing and guard infill panels shall be signed and sealed by a Professional Engineer licensed in the jurisdiction where the Project occurs, attesting to the ability of the metal panel's assembly to withstand the specified loads.

.8 Panels shall be identified on the shop drawings, using the Specified Identification and as to building location to facilitate panel removal and replacement.

1.6 LEED SUBMITTALS:

.1 Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content

## 1.7 DELEGATED DESIGN REQUIREMENTS

.1 Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated

.1 If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

.2 Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional

.1 Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

.3 Infill at railings and guards: Design metal panel infill for railings and guards, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

.1 Structural Performance of infill at railings and guards: Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft

.4 Exterior Panels, Structural Performance: Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

.1 Wind Loads on Exterior Items: As indicated on the General Structural Notes on the drawings or if not indicated; 30 lb/sq. ft.

## 1.8 PRODUCT DELIVERY, HANDLING AND STORAGE

.1 Store components and materials in accordance with panel manufacturer's recommendations.

## 1.9 WARRANTY

.1 Submit panel manufacturer's written warranty covering failure of factory-applied exterior finish within the warranty period. Warranty period for finish: One year after the date of Substantial Completion.

## PART 2 – PRODUCTS

### 2.1 MANUFACTURER OF DECORATIVE METAL PANELS

1. Manufacturers of Decorative Metal Railings: Basis of this specification is Revamp Panels, LLC, www.revamppanels.com Products: As Indicated. Products by others may be considered provided the product is submitted for approval in accordance with the Supplementary Instructions to Bidders and Division 1 Specifications, meets the specified requirements and in the opinion of the Architect, conforms to the general properties of the product listed, including color.

.1 Decorative Screen Panel Assembly Part No.: DSPA-20-0430

### 2.2 PROPERTIES OF DECORATIVE PANELS

1. Panels: 1/8-inch thick formed with 1½-inch return flange on four sides with laser-cut decorative pattern
2. Pattern Design: Custom Design as indicated
3. Panels shall be mechanically fastened to vertical and horizontal framing members
4. Fasteners shall be Stainless Steel
5. Inline Posts: 1/4-inch thick formed into 4 x 2 ½-inch channel
6. Corner Posts: 1/4-inch thick formed into 4 x 4-inch channel with 2 1/2-inch return flanges
7. Baseplates: 3/8-inch thick plate
8. Flat Bar Support: 1/4-inch thick plate

### 2.3 PRODUCTS

2.3.1 General: Provide panels as indicated on the Drawings:

### 2.4 PANEL MATERIALS:

2.4.1 Steel Panels: A36 Hot Rolled, Pickled and Oiled

### 2.5 PANEL FINISHES:

2.5.1 Finishes General: All components shall be factory finished for assembly
2.5.2 Cardinal Powder Coat: www.cardinalpaint.com

### 2.6 COLOR:

2.6.1 Panel Color: T002-BK08 (Black #27038 20% Gloss)
2.6.1.1.1 Primer Coat: E396-GR1327 “Gray Zinc Rich Primer” at min. 2.0-2.5 mils

2.7 FABRICATION:

2.7.1 Fence Panels shall be prefabricated, finished, and ready for installation
2.7.2 Posts shall be welded to Baseplates, finished, and ready for installation
2.7.3 Flat Bar Supports shall be prefabricated, finished, and ready for installation
2.7.4 All welds shall be continuous at all connections
2.7.5 All welds shall be watertight and ground smooth

PART 3 — EXECUTION

3.1 EXAMINATION

.1 Examine work of other Sections upon which work of this Section depends.
.2 Report any unsatisfactory conditions to Architect in writing. Do not start work until unsatisfactory conditions are rectified.

3.2 PANEL SYSTEM

.1 Erect panels and accessories in accordance with system manufacturer's details and instructions and so as to meet specified design and performance requirements.
.2 Finished work shall be securely anchored, free of distortion and surface imperfections, uniform in color and gloss.
.3 Use concealed fastenings only, except where exposed fastenings are specifically permitted by Architect in writing.
.4 Install panels plumb, true, level and in alignment to established lines and elevations.
.5 Where indicated on drawings or as required to complete work of this Section, furnish and install closures, caps, fascia covers and trims with matching panel finish, where exposed.

3.3 CLEAN-UP

.1 Remove protective film from panels.
.2 Clean exposed panel surfaces in accordance with manufacturer's instructions.
.3 Repair and touch up minor surface damage with Cardinal DC1 color matching high grade enamel, only where permitted by the Architect and only where appearance after touch-up is acceptable to Architect.
.4 Replace damaged panels and components that, in opinion of the Architect, cannot be satisfactorily repaired.

END OF SECTION

# 32 33 01 - SITE FURNISHINGS-BENCH

BENCH

## Part 1 General

1.01 Summary

A. Section Includes:

1. Backed bench, 6 foot, aluminum frame, FSC 100% Ipé hardwood slats.

1.02 Submittals

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Product data:

1. Manufacturer's standard product literature.
2. Shop drawings.
3. Installation instructions.
4. Maintenance instructions.

C. Submit powdercoat finish samples for approval.

1.03 Quality Assurance

A. Manufacturer Qualifications:

1. Minimum 15 years experience in the manufacture of site seating.
2. Forest Stewardship Council ("FSC") Certified Supplier. Provide manufacturer's FSC certification number.
3. Provide reference list of at least ten major transportation authorities, municipalities, universities, or

   other high-use public environments currently using site seating fabricated by the manufacturer.

1.04 Delivery, Storage and Handling

A. Handle products in accordance with manufacturer's instructions.

B. Store products in manufacturer's original packaging until ready for installation.

C. Protect products from impacts and abrasion during storage.

1.05 Warranty

A. Provide manufacturer's standard warranty:

1. Warranty terms: one year from date of invoice against defects in materials and workmanship.

## Part 2 Products

2.01 Manufacturer

A. Basis-of-design product: provide backed and/or backless benches based on the product named:

1. Knight Bench by Forms+Surfaces.
2. Manufacturer Contact:
   Forms+Surfaces
   30 Pine Street

Pittsburgh, PA 15223
phone: 800-451-0410
fax: 412-781-7840
email: sales@forms-surfaces.com
website: www.forms-surfaces.com

B. Benches
   1. Materials:
      a. Seat slats
         1) FSC 100% Ipé hardwood.
      b. Bench frame: solid aluminum with invisible welds.
      c. Slat fasteners: recessed stainless steel.
      d. Optional armrests: solid aluminum.
   2. Finishes
      a. Bench slats:
         1) Wood: Penofin® hardwood formula “Transparent Natural.”
      b. Bench frame (outer frame edges): polished aluminum.
      c. Bench frame (inner surfaces): polyester powdercoat
         1) Standard Texture from Forms+Surfaces Powdercoat Chart.
   3. Dimensions
      a. Backed bench, six foot, surface mount
         1) Overall dimensions: 72" long x 22.7" deep x 31.1" high.
         2) Seat dimensions: 15.2" deep x 18" high.
         3) Back height: 15.2".
   4. Mounting:
      a. Surface mount. Provide threaded anchors and stainless steel mounting hardware.
      b.

## Part 3 Execution

### 3.01 Examination

A. Verify that substrates are stable and capable of supporting the weight of items covered under this section.

B. Verify that substrates have been adequately prepared to securely anchor those items that will be surface mounted.

### 3.02 Installation

A. Install according to the manufacturer’s installation instructions.

B. Install in conformance to applicable ADA guidelines and End User’s established Accessibility policies.

END OF SECTION

# 32 33 02 - SITE FURNISHINGS - PEDESTRIAN LIGHT

## PEDESTRIAN LIGHT

### Part 1 General

1.01 Summary

A. Section Includes:

1. Rincon Pedestrian Lighting.

1.02 Submittals

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Product data:

1. Manufacturer's standard product literature.
2. Shop drawings.
3. Installation instructions.
4. Maintenance instructions.

1.03 Quality Assurance

A. Manufacturer Qualifications:

1. Minimum 15 years experience in the manufacture of outdoor lighting.
2. Provide reference list of at least ten major transportation authorities, municipalities, universities, or other high-use public environments currently using outdoor lighting fabricated by the manufacturer.

1.04 Delivery, Storage and Handling

A. Handle products in accordance with manufacturer's instructions.

B. Store products in manufacturer's original packaging until ready for installation.

C. Protect products from impacts and abrasion during storage.

1.05 Warranty

A. Provide manufacturer's standard warranty:

1. Warranty terms: one year from date of invoice against defects in materials and workmanship.

### Part 2 Products

2.01 Manufacturer

A. Basis-of-design product: provide pedestrian lighting based on the product named.

1. Rincon Pedestrian Lighting by Forms+Surfaces
2. Manufacturer Contact:
   Forms+Surfaces
   30 Pine Street
   Pittsburgh, PA 15223
   phone: 800-451-0410
   fax: 412-781-7840
   email: sales@forms-surfaces.com
   website: www.forms-surfaces.com

B. Pedestrian Lighting
1. Materials:
a. Body: .06" (1.5 mm) stainless steel.
b. Base: stainless steel.
c. Head Cap: stainless steel casting.
d. Lens: .25" (6.35 mm) thick white-frosted acrylic.
e. Optional Directional Shield(s): 35.76” high x 4.18” wide stainless steel
1) Shield Pattern
1. Huron.
2) Shield Location(s)
1. Four shields.
f. LED Driver: Input power is 90 – 305 VAC. Includes high efficiency, constant output current, with over-voltage, short circuit, overload protection, and has 0-10V dimming capabilities. Certifications include: IP66 (waterproof) enclosure, and Class 2 rated output (UL8750.
g. LED Light Engine
1) LED 3000K:
1. 30W custom LED light engine.
2. Luminaire lumens: 2880.
3. Color temperature: 3,000K.
2. Finish:
a. Body and Head Cap:
1) Stainless steel with Satin finish.
b. Base:
1) Stainless steel with Satin finish.
c. Optional Directional Shield(s):
1) Stainless steel with Satin finish.

3. Dimensions:
a. 117" high x 4.5" wide x 4.5" deep
b. base plate: 2” high x 7.5” wide x 7.5” deep
4. Mounting: Surface mount with 0.375” thick stainless steel base plate. Provided: stainless steel cover and necessary hardware. Template available upon request.

## Part 3 Execution

### 3.01 Examination

A. Verify that substrates are stable and capable of supporting the weight of items covered under this section.
B. Verify that substrates have been adequately prepared to securely anchor those items that will be surface mounted.

3.02 Installation

A. Install according to the manufacturer's installation instructions.

B. Install in conformance to applicable ADA guidelines and End User's established accessibility policies.

END OF SECTION

# 32 33 03 - SITE FURNISHINGS - BOLLARD LIGHT

## BOLLARD LIGHT

### Part 1 General

1.01 Summary

A. Section Includes:
   1. Rincon Bollard.

1.02 Submittals

A. Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
B. Product data:
   1. Manufacturer's standard product literature.
   2. Shop drawings.
   3. Installation instructions.
   4. Maintenance instructions.
C. Submit powdercoat finish samples for approval.

1.03 Quality Assurance

A. Manufacturer Qualifications:
   1. Minimum 15 years experience in the manufacture of outdoor lighting.
   2. Provide reference list of at least ten major transportation authorities, municipalities, universities, or
      other high-use public environments currently using outdoor lighting fabricated by the manufacturer.

1.04 Delivery, Storage and Handling

A. Handle products in accordance with manufacturer's instructions.
B. Store products in manufacturer's original packaging until ready for installation.
C. Protect products from impacts and abrasion during storage.

1.05 Warranty

A. Provide manufacturer's standard warranty:
   1. Warranty terms: one year from date of invoice against defects in materials and workmanship.

### Part 2 Products

2.01 Manufacturer

A. Basis-of-design product: provide bollards based on the product named.
   1. Rincon Bollard by Forms+Surfaces
   2. Manufacturer Contact:
      Forms+Surfaces
      30 Pine Street
      Pittsburgh, PA 15223
      phone: 800-451-0410
      fax: 412-781-7840

email: sales@forms-surfaces.com
website: www.forms-surfaces.com

B. Bollards
1. Materials:
a. Body: .06" (1.5 mm) stainless steel.
b. Base: stainless steel casting.
c. Head Cap: stainless steel casting.
d. Lens: .25" (6.35 mm) thick white-frosted acrylic.
e. Optional Directional Shield(s): 10.76" high x 4.18" wide stainless steel
1) Shield Pattern
1. Huron.
2) Shield Location(s)
1. Four shields.
f. LED Driver: Input power is 90 – 305 VAC. Includes high efficiency, constant output current, with over-voltage, short circuit, overload protection, and has 0-10V dimming capabilities. Certifications include: IP66 (waterproof) enclosure, and Class 2 rated output (UL1310 / UL8750.
g. LED Light Engine
1) LED 3000K:
1. 14W custom LED light engine.
2. Luminaire lumens: 1020.
3. Color temperature: 3,000K.
2. Finish:
a. Body and Head Cap:
1) Satin.
c. Optional Directional Shield(s): Satin.
3. Dimensions: 36.2" high x 4.5" wide x 4.5" deep.
4. Mounting: Surface mount with 4.5" x 4.5" base using four tamper-resistant bolts. Necessary hardware is included. Templates available upon request.

## Part 3 Execution

### 3.01 Examination

A. Verify that substrates are stable and capable of supporting the weight of items covered under this section.
B. Verify that substrates have been adequately prepared to securely anchor those items that will be surface mounted.

### 3.02 Installation

A. Install according to the manufacturer's installation instructions.
B. Install in conformance to applicable ADA guidelines and End User's established accessibility policies.

END OF SECTION

# 32 33 04 -SITE FURNISHINGS - METAL EDGE

## METAL EDGE

## PART 1 GENERAL

### 1.01 WARRANTY

A. 15-year limited material warranty for landscape edging from manufacturing defects in workmanship or material.

## PART 2 PRODUCTS

### 2.01 PLANTING ACCESSORIES

A. Heavy Duty Straight Profile Edging: Permaloc CleanLine XL, 3/16 inch (4.8mm) x 6 inch (152mm) high, extruded aluminum, 6063 alloy, T-6 hardness, landscape edging for straight-line and curvilinear applications in corrugated straight profile, as manufactured by Permaloc Corporation, Holland MI 49424, telephone (800) 356-9660.

B. Thickness: 3/16 inch (4.8 mm) gage section at 0.116 inch (2.95 mm) minimum thick with 0.375 inch (9.53 mm) exposed top lip.

C. Length: 16 foot (4.8m) sections.

D. Connection Method: Section ends shall splice together with the sliding XLR Adaptor.

E. Stake: 24 inch (610mm) Permaloc extruded aluminum stake. Stakes to connect to edging via sliding XLR Adaptors.

F. Finish: Black DuraFlex. Paint finish shall comply with AAMA 2603 for electrostatically baked on paint.

## PART 3 EXECUTION

### 3.01 LANDSCAPE EDGING INSTALLATION

A. Preparation: Ensure that all underground utility lines are located and will not interfere with the proposed edging installation before beginning work. Locate border line of edging with string or other means to assure border straightness and curves as designed. Dig trench 1 inch (25 mm) deeper than set of edging bottom.

B. Set edging into trench with top at 1/2 inch (12.7 mm) above compacted finish grade on turf side with side having loops for stakes placed on opposite side of turf. Drive stakes through edging loops until locked in place. Requires 5 stakes evenly spaced for each 16 feet (4.88 meters) section, or requires 3 stakes evenly spaced for each 8 feet (2.44 meters) section. Provide additional stakes at approximately 24 inches apart, longer stakes, heavier gage stakes, or any combination of previously mentioned as necessary to firmly secure edging for permanent intended use.

C. Where edging sections turn at corners and at angled runs, cut edging partially up through its height from bottom and turn back to desired angle to form rounded exposed radius. Preformed corners available upon request.

D. Backfilling and Cleanup: Backfill both sides of edging, confirm and adjust if necessary that sections are securely held together, and compact backfill material along edging to provide top of edging at 1/2 inch (12.7 mm) above turf finish grade. Cleanup and remove excess material from site.

END OF SECTION

**SECTION 32 92 00**

**TURF AND GRASSES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. Sodding.
4. Erosion-control materials.
5. Fertilizing

B. Related Requirements:

1. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as topsoil.
2. Section 31 23 18.13 "Subtitle D Waste Disposal" for handling and disposal of soil wastes.
3. Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil" for handling and disposal of soil wastes.
4. Section 31 23 23 "Acceptance of Backfill, Top Soil, & CU Structural Soil" for handling and importation of all backfill.

### 1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer and Manufacturer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

C. Soil Test Analysis: As specified in Section 32 93 00 “Plants”.

D. Product Certificates: For fertilizers, from manufacturer.

E. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

B. Manufacturer Qualifications: Provide manufacturer qualifications as follows:

1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.

C. Investigate sources of supply and confirm they can supply materials in quantity, variety, and quality noted and specified before submitting bid.

D. Comply with State and Federal laws with respect to inspection for plant diseases and insect infestation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

1. Inform Architect 24 hours in advance of delivery of sod. Each shipment shall be accompanied by an invoice from manufacturer giving quantity and certifying that sod meets specified requirements, together with analysis of seed from which sod was grown. Provide copy of invoice to Architect upon delivery of sod.
2. Do not delivery more sod than can be laid within 24 hours.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

A. Fertilizer: Deliver fertilizer to site in unopened, original containers, each bearing name and address of manufacturer, name brand, or trademark, and manufacturer's guaranteed analysis. Do not use fertilizer which becomes caked or otherwise damaged. Do not expose fertilizer to weather prior to delivery on site and after delivery until used. Protect fertilizer and do not store in direct contact with ground.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: March 15 to June 15.
2. Fall Planting: August 15 to November 15.
3. Seasons may be extended upon approval by Architect, however, such time extensions shall not change Contractor's responsibility for establishing healthy appearing and vigorous growing turf.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

## PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality: State-certified seed of grass species as listed below.
2. Quality: Seed of grass species as listed below, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
3. Seed type: Tall Fescue blend, a minimum of three cultivars.

    a. 90 percent Tall Fescue (minimum 3 three cultivars).
    b. 10 percent perennial rye

2.2 TURFGRASS SOD

A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.

1. Sod shall be fresh cut, live, nursery grown sod having well matted roots. It shall contain no bent grass, quack grass or other noxious weed growth and shall be free from fungus and other pests and/or diseases. Peat sod will not be acceptable.
2. Root zone shall be of good, fertile, natural mineral soil free from stones and debris.
3. Sod Sections: Standard in size (18 in. wide by 6 ft in length) not less than 1-1/2 in. thick, strong enough to support its own weight and retain its size and shape when suspended vertically from firm grasp on upper 10% of section.
4. Mowed at least twice with final mowing not more than 7 days before being cut and lifted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

1. Tall Fescue with a minimum of three cultivars.

2.3 SOIL MATERIALS

A. Topsoil: Type indicated and as specified in Section 329300 “Plants”.

2.4 FERTILIZERS

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium:

B. Prior to seeding (18-24-12); recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:

1. Nitrogen: 18 percent.
2. Phosphoric Acid: 24 percent.
3. Soluble Potash: 12 percent.

C. Prior to sodding (6-24-24); recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:

1. Nitrogen: 6 percent.
2. Phosphoric Acid: 24 percent.
3. Soluble Potash: 24 percent.

D. After sodding (18-5-9); recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:

1. Nitrogen: 18 percent.
2. Phosphoric Acid: 5 percent.
3. Soluble Potash: 9 percent.

E. One-quarter of nitrogen shall be in form of nitrates, one-quarter in form of ammonia salts, and one-half in form of organic nitrogen.

F. Available phosphoric acid shall be derived from super-phosphate having minimum guaranteed analysis of 20% available phosphate or bone meal.

G. Potash shall be in form of sulphate of potash.

H. Make up balance of fertilizer of nonharmful materials normally present in such product and free from dust, sticks, sand, stone or other harmful debris.

2.5 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

## 2.6 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## 2.7 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat. enclosed Photodegradable mesh to be 60 day maximum. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 6-inch (150-mm) nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

C. Verify location of underground utilities with appropriate sources. Contact D.I.G.G.E.R. at least 48 hours before commencing with construction. Repair damaged utilities.

D. Verify that prepared soil base is ready to receive the work of this section. Do not begin site preparation until boulders, debris, and similar materials have been removed; depressions and ruts filled; and entire area has been shaped, trimmed and finished uniformly to lines, grades, and cross-sections shown on drawings.

E. Proceed only after unsatisfactory conditions have been corrected. Commencement of work in this section will be an indication of the acceptance of sub-grade and the Contractor will be held responsible for the satisfactory execution and results of the finished work.

### 3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

### 3.3 TURF AREA PREPARATION

A. Placing Planting Soil: Place planting soil to a depth of 12 inches beneath turf areas. Place soil in 6 inch lifts. Compact each lift to the extent necessary to prevent settlement.

1. Reduce elevation of planting soil to allow for soil thickness of sod.

B. Finish Grading:

1. Provide smooth continual grades without dips and pockets where water may stand.
2. Correct surface irregularities produced by preceding operations or by any other cause.
3. Finish grades and earth mounds shall be approved by Architect prior to lawn construction.

C. Tilling:

1. Prepare areas to depth of approximately 3 in. by disking, harrowing or other approved means.
2. Areas shown on drawings which are too small to make these operations practicable shall receive special scarification prior to final tilling.
3. Continue tilling until soil condition is suitable for turf construction.
4. After completion of tilling operations, clear surface of stones, stumps, roots, brush, wire, grade stakes, construction materials, and other objects which hinder planting, installation, and maintenance operations.

D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

F. Keep adjacent paved areas clean.

3.4 FERTILIZING

A. Apply fertilizer per manufacturer instructions.

B. Apply after smooth raking of topsoil and prior to seeding and installation of sod.

C. Apply fertilizer at a rate of 10 lbs per 1,000 square feet using a steel-geared rotary spreader no more than 48 hours before seeding or laying sod. Spread uniformly in two passes at right angles to each other.

D. Mix thoroughly into upper 2 inches of topsoil by disking, harrowing or other methods which produce similar results.

E. Lightly water to aid the dissipation of fertilizer.

3.5 PREPARATION FOR EROSION-CONTROL MATERIALS

A. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

B. Fill cells of erosion-control mat with planting soil and compact before planting.

C. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

D. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

## 3.6 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h).

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft. (2.3 to 3.6 kg/92.9 sq. m).

C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
2. Bond straw mulch with the use of hydroseeding in large applications. Asphalt emulsion is not permitted. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

G. Protect seeded areas from hot, dry weather or drying winds by applying planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch (4.8 mm), and roll surface smooth.

## 3.7 HYDROSEEDING

A. Hydroseeding: Mix specified seed, slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre (15.6-kg/92.9 sq. m) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

## 3.8 SODDING

A. Moisten prepared surface immediately prior to laying sod.

B. Lay sod by hand immediately after delivery to site to prevent deterioration. Lay sod within 24 hours of harvesting unless a suitable preservation method is accepted by Architect prior to delivery time. Do not lay sod if dormant or if ground is frozen or muddy.

C. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

D. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

## 3.9 TURF RENOVATION

A. Renovate existing turf where indicated.

B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal" or Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," as applicable.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).

I. Apply initial fertilizer required for establishing new turf and mix thoroughly into top 4 inches (100 mm) of existing soil. Install new planting soil to fill low spots and meet finish grades.

1. Initial Fertilizer: Slow-release fertilizer applied according to manufacturer's recommendations.

J. Apply seed and protect with straw mulch, or sod as required for new turf.

K. Water newly planted areas and keep moist until new turf is established.

3.10 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.

C. Mowing: The contractor shall cut grass starting when the grass becomes 3-inches high, and once a week thereafter, or as often as necessary to maintain the grass height at 3”, without removing more than 1/3 of the leaf blade at any cutting.

1. Included in the cutting of grass shall be the cutting and trimming required around trees, drainage structures, curbs and all areas that grass abuts, as required or directed by the engineer.
2. The contractor shall maintain a height of not less than 3 inches.
3. Immediately remove clippings after mowing and trimming.

D. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to turf area.

## 3.11 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).
2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

## 3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

## 3.13 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal" or Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," as applicable.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

## 3.14 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until the date of Substantial Completion of the project.

1. The Contractor shall be responsible for at least three mowings
2. The Contractor shall be responsible for turf postfertilization after the initial mowing.

**END OF SECTION**

**SECTION 32 93 00**

**PLANTS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. New trees, plants, and ground cover.
2. Mulch and Fertilizer.
3. Tree Pruning.
4. Maintenance.

B. Related Requirements:

1. Section 01 56 39 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 31 23 18.13 "Subtitle D Waste Disposal" for handling and disposal of soil wastes.
3. Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil" for handling and disposal of soil wastes.
4. Section 31 23 23 "Acceptance of Backfill, Top Soil, & CU Structural Soil" for handling and importation of all backfill.
5. Section 32 92 00 "Turf and Grasses" for turf (lawn), hydroseeding, and erosion-control materials.
6. Section 32 96 00 "Transplanting" for transplanting non-nursery-grown trees.

### 1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

G. Finish Grade: Elevation of finished surface of planting soil.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

P. Weeds: Any plant life not specified or scheduled.

Q. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

## 1.4 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

## 1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. At minimum review the following:

1. Review the drawings and specifications for this work.
2. Plant locations and procedures for adjustment.
3. Procedures for work on public property.
4. Maintenance procedures for surrounding streets, walks, paving and site amenities.

## 1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
3. Tree Tagging: Contractor or nursery shall locate all trees and tag them with a seal. Contractor is to photograph each individual tree and provide each image with the seal number, variety, size, and nursery location labeled on the image. No trees shall be accepted unless they have a seal from the contractor or landscape architect.

    a. In addition to review of plant material photographs, Architect may inspect and tag plant material at nursery. Such inspection shall be in addition to inspection at job site.

4. Tagging Log: Contractor shall keep a log detailing information for each tagged tree. Such information shall include the source nursery where the material is tagged, location within nursery, size of trees, tag or seal numbers, colors of flagging tape (if applicable), canopy height, spread, and branching height. Provide submittal before beginning construction.

B. Samples for Verification: For each of the following:

1. Mulch: 1-quart (1-L) volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
2. Slow-Release, Tree-Watering Device: One unit of each size required.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

D. Soil Test Analysis:

1. Submit copies of test analysis indicating pH, percentages of gravel, sand, silt, clay, organic matter, and major micronutrient groups in the analysis for imported topsoil and topsoil from site (if any).
2. Provide environmental analysis of representative soil samples (no composite samples) in accordance with Division 31 Section "Acceptance of Backfill, Topsoil and CU Structural Soil" and submit analytical results to the CHA's Designated Representative for approval 10 working days prior to start of project. For samples from virgin sources, one representative sample must be analyzed for 35 ILL. ADM CODE 740 APPENDIX A Target Compound List (TCL) parameters. For samples from recycled sources, one sample per 1,000 tons of material must be analyzed for 35 ILL. ADM CODE 740 APPENDIX A Target Compound List (TCL) parameters. The date of the topsoil analysis shall be within 60 days of importing such material to the site.
3. Include in the analysis recommended amounts of fertilizer and other soil amendments needed to bring the topsoil into compliance with the requirements of this Section. The State of Illinois restricts the use of phosphorus unless it is demonstrated the soil is deficient. Adhere to all aspects of 415 ILCS 65/a Lawn Care Products Application Notice.
4. Furnish Architect with 5 copies of test analysis report.

E. Percolation Test results:

1. Perform percolation tests in tree pits as required by the Chicago Landscape Ordinance. Submit a log of the percolation rates, with a plan outlining the locations of each test pit, before planting trees.

F. Comply with State of Illinois and federal laws with respect to inspection of all plants for plant diseases and insect infestation. Submit an inspection certificate, required by law to this effect, with each shipment.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by the CHA for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation in addition to requirements in Section 01 40 00 "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor with five years' experience installing plant material on Project site when work is in progress.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1. All plants shall be obtained from reputable nurseries, licensed by the State of Illinois and approved by the Architect.

C. Investigate sources of supply and confirm they can supply plants specified on plant list in sizes, variety, and quality noted and specified. Failure to take this precaution will not relieve responsibility for furnishing and installing plant material in accordance with Contract requirements. Substitutions may be permitted only upon submission of written proof that specified plant is not obtainable locally. Such substitution may be made upon written authorization by Architect.

D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

E. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

F. Rejection of Plant Material:

1. The Architect has the right to reject any and all plant material that does not conform to the requirements of this specification.
2. Evidence of damage to plant material, which destroys the natural character of the plant, shall be cause for rejection.
3. When a plant has been rejected, remove it from the area of the work and replace it with one of the required size and quality. Replacement plant material shall be approved by Architect. The Contractor shall bear the total cost of replacing rejected plant material.
4. Any plant that has the following characteristics shall be cause for rejection:

    a. Any tree that has a canopy with 10% or more dead limbs.
    b. Any tree that has dead limbs that, when removed, will result in the loss of 10% or more of the structure and form of the canopy of the tree.
    c. Any tree that is of a species that characteristically has a dominant central leader, and if the leader is dead, when removed the tree will not have a form consistent with the species.
    d. The plant material does not meet Architect's expectations based upon the photographs.

5. Any tree that has open wounds (not completely healed over) that penetrates the bark to the wood on trunks or major limbs the removal of which would result in the loss of 10% or more of the structure and form of the tree.

G. Percolation Test: Perform percolation tests to determine the permeability of the sub-grade as required by the Chicago Landscape Ordinance, and where indicated on Drawings, as follows:

1. For every 5-15 trees and shrubs in a general area, excavate a 12" diameter x 12" deep test pit. Fill each pit with water and allow water to percolate out. Test pits shall be roped off at all times and filled in when test is complete.
2. If water does not percolate out over a 12-hour period, contact Architect.
3. Although only one tree percolation test is required for every 15 trees, the Contractor is still responsible for ensuring that every tree drains properly.

## 1.10 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable. Store in weatherproof storage areas and in such a manner that their effectiveness will not be impaired.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

C. Deliver bare-root stock plants within 36 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system

moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Dig balled and burlapped stock plants and prepare for shipment in a manner that will not damage roots, branches, shape and future development of the plants. Drumlace plants 2 inches in caliper and over.

F. Handle planting stock by root ball.

G. Provide container for balled and potted stock plants, and container-grown stock plants, to hold ball shape protecting root mass during delivery and handling.

H. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.

I. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting. Plant container-grown stock immediately once removed from container.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.
5. Provide proper spacing for trees, such that the stockpiled plant material has full access to light and air. Take all precautions to prevent defoliation of stockpiled material.
6. Plants shall not remain unplanted for longer than 3 days. Plant material subject to improper storage procedures shall be rejected.

J. Each shipment shall be accompanied by invoice showing sizes and varieties of plants included in each shipment. Provide copy of invoice to Architect upon delivery of plant material.

1. Upon delivery and before planting request inspection of plants by Architect.
2. Notify Architect a minimum of 24 hours before delivery of plant material.
3. Failure to notify Architect in advance, in order to arrange proper scheduling may result in loss of time or removal of plant or plants not installed as specified or directed.
4. Inspection and approval is for quality, size, and variety only, and in no way impairs right of rejection for failure to meet other requirements during progress of Work.
5. Contractor shall be present during required inspection or as may be required by Architect.

1.11 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: From time soil becomes workable to June 15.
2. Fall Planting: September 1 to November 15. Plant evergreen shrub plantings no later than November 1, and evergreen tree plantings no later than October 15.
3. Summer Season: June 2 through August 31. Planting shall be considered unseasonable and shall require approval by Architect. Approval to plant under such conditions shall in no way relieve Contractor from guarantee provisions of these specifications.
4. Container Plants: Planting season designated above may be extended for container grown plants when approved by Architect.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
b. Structural failures including plantings falling or blowing over.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods: From date of Substantial Completion.

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
c. Annuals: Three months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.

d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

## PART 2 - PRODUCTS

### 2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
3. Provide plants grown within same hardiness zone as project site or have been acclimated to conditions of same hardiness zone for minimum of two growing seasons. Hardiness zones shall conform to "Zones of Plant Hardiness" as provided by U.S. Department of Agriculture.
4. Plants shall be freshly dug or container-grown. No heeled-in plants or plants for cold storage will be accepted, except as otherwise specified, unless Contractor makes such request in writing and plants are inspected and approved.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

1. Measure plants when branches are in their normal position. Height and spread refer to plant's main body and not from branch tip to branch tip.
2. Take caliper measurement at point on trunk 6 inches above natural ground line for trees up to 4 inches in caliper and at point 12 inches above natural ground line for trees 4 inches and over in caliper.
3. If range of size is given, no plant shall be less than minimum size and not less than 50% of plants shall be as large as upper half of range specified.
4. Measurements specified are minimum size acceptable and are measurements after pruning, where pruning is required. Plants meeting measurements specified, but not producing normal balance between height and spread, are not acceptable.
5. Shrubs shall be matched specimens from single block source.
6. Plants shall be true to species and variety and shall conform to measurement specified in Plant List except that plants larger than specified may be used if approved by Architect. The Contractor shall bear the cost of the use of larger plants.
7. Where plants larger than specified have been submitted in writing for approval and approved in writing by Architect, Contractor shall assume responsibility of guarantee for plant in size as planted.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.

E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery.

G. Balled and Burlapped Plants (Designated B&B):

1. Dig plants with firm natural balls of earth of diameter indicated below and of sufficient depth to encompass fibrous and feeding root system necessary for full recovery of plant.
2. Plants having balls broken or cracked during delivery or at time of planting will be rejected.
3. For Evergreen trees, trunk diameter shall be used to determine minimum required ball dimensions. Minimum ball dimensions shall be those as specified for single stem trees.
4. Diameter at top of each ball shall be diameter specified above and diameter at bottom of each ball shall not be less than 70% of specified top diameter. Top and bottom sources shall be parallel.
5. Ball shall be of specified depth at points perpendicular to bottom of ball.
6. Balls greater than 30 inches diameter shall be drum-laced.
7. Architect may reject any plant specified as balled and burlapped which fails to conform, in the Architect's opinion, to balling requirements set forth herein.

H. Container or Pot Grown Plants:

1. Container grown plants shall have heavy fibrous root system, or well developed taproot, that has been developed by proper horticultural practice including transplanting and root pruning.
2. Root system shall have developed sufficiently long for new fibrous roots to develop so root mass will retain its shape and hold together when removed from container.
3. In no case should container strangle or girdle natural growth of plant.
4. Groundcovers in containers pots shall have the minimum number of runners and length of runners in accordance with ANSI/AHIA Z60.1.
5. Diameter of spread shall determine inside diameter of pot in which they shall be grown for at least 3 months prior to delivery.
6. Plant container sizes shall conform to ANSI/AHIA Z60.1.

I. Deciduous (Shade and Ornamental Trees):

1. Street tree plantings shall be free of branches equivalent to 1/2 of tree height or so that crown of tree is in proportion to trunk as tree grows.

a. Trees with ascending branches may be branched 1 foot or more below branch heights as listed.

2. Provide trees of specimen quality.

J. Evergreen Trees/Shrubs:

1. Provide evergreen trees of specimen quality.
2. Provide evergreen shrubs of specimen quality.
3. Columnar plants:

a. Provide columnar plants of specimen quality.

K. Deciduous Shrubs:

1. Provide deciduous shrubs of specimen quality.

L. Perennial, Biennials, Prairie Forbes, and Grasses:

1. Perennial, biennials, prairie forbs, and grasses specified as "container" or "pot" shall be provided as container grown plants, or shall be provided with firm natural balls of earth with diameter and depth in accordance with American Standard for Nursery Stock for size specified on Plant List.
2. Ship balled plants in open-air boxes or crates that will minimize handling of each plant prior to installation. Do not plant balled plants if ball is cracked or broken either before or during process of planting.

2.2 SOIL MATERIALS

A. Topsoil: loamy soil from the A horizon of soil profiles of local soils. It shall be relatively free from large roots, sticks, weeds, brush, or stones larger than 25 mm (1 inch) in diameter, or other litter and waste products. At least 90 percent must pass the 2.00 mm (No. 10) sieve and the pH must be between 5.0 and 8.0.

1. Composition: 45-77 percent silt, 0-25 percent clay, 25-33 percent sand.
2. Acidity: pH 6.0 to 7.0; amend soil as indicated by tests to achieve this pH range.
3. Organic content: Three to five percent.
4. Environmental analysis requirements shall be in accordance with Section312323 Acceptance of Backfill, Top Soil, CU Structural Soil.
5. Import topsoil conforming to above requirements from off-site sources as requiredto complete the work. Do not obtain from bogs or marshes.
6. Perform test analysis on each source of topsoil to demonstrate compliance with the above and submit reports as specified.

2.3 SOIL AMENDMENT MATERIALS

A. Fertilizer: Commercial type, uniform in composition, free flowing, conforming to state and federal laws, and suitable for application with equipment designed for that purpose.

1. Nitrogen: 6%, 1/4 of nitrogen shall be in form of nitrates, 1/4 in form of ammonia salts, and 1/2 in form of organic nitrogen.

2. Phosphorus: 24%, available phosphoric acid shall be derived from super phosphate having minimum analysis of 20% available phosphate.
3. Potash: 24%, potash shall be in form of sulphate of potash.
4. Balance of fertilizer shall be materials usually present in such products, free from dust, sticks, sand, stone, and other debris.

B. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

1. Existing water supply from hose bibs at the project building may be used for all planting operations. Provide hose and equipment necessary for proper watering of plant material. Provide water at no extra cost if it is not available at the project site.

2.4 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of the following:

1. Type: Shredded hardwood bark mulch.
2. Size Range: 60% shall range between 1 inch and 3 inches in length; remaining 40% shall not exceed 1-1/2 inches
3. Color: Natural.
4. Installation Depth: 3 inches.

B. Organic Mulch: Free from deleterious materials and suitable as a top dressing of groundcover and perennials, consisting of the following:

1. Type: Decomposed shredded hardwood mulch
2. Size Range: 60% shall range between 1 inch and 3 inches in length; remaining 40% shall not exceed 1-1/2 inches
3. Color: Natural.
4. Installation Depth: 2 inches.
5. Mulch shall not be placed over trailing stems or crown of the plants.

2.5 PESTICIDES

A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.6 TREE-WATERING DEVICES

A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over one to two weeks; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

1. Color: green.

2.7 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.

B. Burlap: Non-synthetic, biodegradable.

C. Drainage Material: Free draining aggregate meeting the requirements of IDOT CA7 and having a pH of 5.5 - 7.

D. Filter Fabric: Nonbiodegradable, needle-punched, non-woven, water permeable, 100% continuous polypropylene or polyester fabric, 3 oz. per sq. yd. minimum, designed for drainage applications without clogging or piping. Capable of withstanding backfilling and compacting operations without tearing or deforming.

E. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb (0.45 kg) of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

1. Soil disposal shall be completed in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal" or Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," as applicable.

C. Do not install plantings where depth of soil over underground construction, obstructions or rock is insufficient to accommodate roots or where pockets in rock or impervious soil will require drainage. Where such conditions encountered in excavation planting areas and where stone, boulders or other obstruction cannot be broke or removed by hand methods and where trees to be planted found under overhead wires, bring to the attention of the Architect. Alternate locations for planting may be designated by Architect.

D. Verify location of underground utilities with appropriate sources prior to construction. Contact D.I.G.G.E.R. at least 48 hours before commencing with construction operations. Repair damaged utilities.

E. Confirm that utility work has been completed per the drawings.

F. Conflicts with utilities shall be called to the Architect's attention before proceeding with work. Alternate locations for planting may be designated by Architect.

G. Remove rock or other underground construction and drain planting areas only when approved by Architect.

H. Remove foreign materials, weeds and undesirable plants and their roots.

I. Verify that prepared subsoil is ready to receive work.

J. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PLANTING SEASON

A. Planting shall only be performed when weather and soil conditions are suitable for planting the materials specified in accordance with locally accepted practice. Install plant materials during the planting time as described below unless otherwise directed by the Architect. Planting shall not occur if soil profiles or frozen or if there is a risk of frost.

| | | |
|---|---|---|
| 1. | Evergreen Trees: | April 1 – July 1 and September 1 - November 1 |
| 2. | Evergreen Shrubs: | April 1 – July 1 and September 1 - November 1 |
| 3. | Deciduous Trees: | April 1 – July 1 and September 1 - November 1 |
| 4. | Deciduous Shrubs: | April 1 – July 1 and September 1 - November 1 |
| 5. | Vines: | April 1 – July 1 and September 1 - November 1 |
| 6. | Ornamental Grasses: | April 1 – July 1 and September 1 - November 1 |
| 7. | Perennials: | April 1 – July 1 and September 1 - November 1 |
| 8. | Groundcover: | April 1 – July 1 and September 1 - November 1 |
| 9. | Bulbs: | October 1 - December 1 |

## 3.3 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Cover surrounding turf (if existing) in manner to protect turfed areas that are to be trucked or hauled over and upon which soil is to be temporarily stocked.

D. Maintain at least one stockpile of topsoil for backfilling plants during planting operations.

E. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Provide 48 hours' notice for approval. Contractor to be present during approval. Make adjustments in locations and outlines as required. In event that pits or areas for planting are prepared and backfilled with topsoil to grade prior to commencement of lawn operations, mark so they can be readily located when work of planting proceeds.

## 3.4 PLANTING AREA ESTABLISHMENT

A. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.

1. Place topsoil during dry weather and on dry unfrozen subgrade. Do not place or work topsoil in frozen or muddy condition.
2. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
3. Establish final grade as shown on drawings. Grades not otherwise indicated are uniform levels or slopes between points where elevations are given or between such points and existing finished grades.
4. Where drawings show existing grades of landscaped areas not to be changed, remove enough material to allow placement of 18 inches of new topsoil and 6 inches of drainage material beneath shrub plantings and 24 inches of topsoil minimum beneath tree plantings, unless existing topsoil to required depth is undisturbed and of equal or better quality than specified herein. In latter case, existing topsoil may be left in place and use only enough new topsoil to bring these areas up to grade.

B. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

C. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

## 3.5 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for balled and burlapped, balled and potted, container-grown and fabric bag-grown stock.
3. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

## 3.6 TREE, SHRUB, AND VINE PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Backfill: Planting soil.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting soil supplements equally distributed around each planting pit when pit is approximately one-half filled or per Manufacturer's instructions.

    a. Quantity: Per Manufacturer's instructions.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.
6. Remove nursery plant identification tags.

D. Balled and Potted and Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Backfill: Planting soil.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting soil supplements equally distributed around each planting pit when pit is approximately one-half filled or per Manufacturer's instructions.

    a. Quantity: Per Manufacturer's instructions.

5. If growing medium is comprised of 75% or more of peat, perlite, sand or like material other than soil, pull visible roots away from container medium so as to leave roots partially exposed.
6. Continue backfilling process. Water again after placing and tamping final layer of soil.
7. Remove nursery plant identification tags.

E. Fabric Bag-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Backfill: Planting soil.
2. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting soil supplements equally distributed around each planting pit when pit is approximately one-half filled or per Manufacturer's instructions.

    a. Quantity: Per Manufacturer instructions.

5. Continue backfilling process. Water again after placing and tamping final layer of soil.
6. Remove nursery plant identification tags.

F. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grade.

1. Backfill: Planting soil.
2. Spread roots without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
3. Carefully work backfill in layers around roots by hand. Bring roots into close contact with the soil.
4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Place planting soil supplements equally distributed around each planting pit when pit is approximately one-half filled or per Manufacturer's instructions.

    a. Quantity: Per Manufacturer instructions.

6. Continue backfilling process. Water again after placing and tamping final layer of soil.
7. Remove nursery plant identification tags.

G. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

## 3.7 MECHANIZED TREE-SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.

C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

D. Cut exposed roots cleanly during transplanting operations.

E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in the same direction as in its original location.

## 3.8 TREE, SHRUB, AND VINE PRUNING

A. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

C. Pruning shall be done with clean, sharp hand pruners or pruning saws. The use of hatchets, axes, shovels or other implements not specifically designed for pruning is prohibited. The use of hedge shears shall be prohibited except for the pruning of specified hedges.

D. All cuts shall be clean and done with properly sharpened tools. When diseased material is pruned, tools shall be properly disinfected before further use.

E. Make cuts flush and clean avoiding injury to branch bark ridge or branch collar leaving no stubs.

F. For cuts greater than 3/4 in. in diameter and bruises or scars on bark, trace injured cambium back to living tissue and remove. Smooth and shape wounds so as not to retain water.

G. Prune flowering trees only to remove dead or damaged branches. Do not remove leader.

H. All debris generated from pruning operations is to be properly disposed of at the end of each work day.

I. Trees:

1. Trees are to be pruned only as necessary to remove:

    a. Dead or injured twigs, branches and/or limbs
    b. Watersprouts and other undesirable adventitious growth arising from the trunk or branches
    c. Sucker shoots and other undesirable basal sprouts. Basal sprouts are to be cut cleanly below the soil line; cut stubs are to be covered with soil to prevent resprouting.

2. Pruning shall be done in such a manner as not to change the natural shape or habit of the tree.
3. All cuts shall be made so as to produce a small collar, but leave no stubs. Cuts shall be made in such a manner as to preclude the tearing, stripping or other damage to adjacent bark, limbs or branches.
4. Cuts shall be made back to a bud, branch or main trunk. Collar cuts shall be made at tree trunks.
5. Limbs over 2” diameter shall be removed with three cuts. The first cut is to undercut by sawing through one-third of the limb. This shall not be more than one foot from the trunk. The second cut is an uppercut one to two inches from the first cut, away from the trunk, on the top of the branch, continued until the branch falls. The third cut shall be to remove the stub with an appropriate flush cut at the trunk.

J. Shrubs:

1. Shrubs are to be pruned as necessary to remove dead and/or injured twigs, branches and limbs. Pruning shall be done in such a manner as not to change the natural shape or habit of the shrub.
2. Shrubs to be renewal pruned will receive such pruning once annually at the optimum time of year for the individual shrub species, generally immediately following flowering; the

method of renewal pruning and the percentage of material removed shall be appropriate for the individual shrub species.

3. When pruning shrubs, the natural shape of the plant is to be maintained at all times. No shearing of shrubs will be permitted except for plantings designated as hedges.

K. Hedges:

1. Hedges are to be sheared as often as necessary during the growing season to maintain a clean, crisp appearance.
2. During hedge work, all weed or volunteer plants growing in or through hedge plantings are to be removed cleanly at the base; shearing to height along with the hedge will not be acceptable.

L. Herbaceous plant material:

1. Annuals and perennials shall be continuously dead-headed to maintain the planting spaces and/or promote flowering or plant growth.
2. Herbaceous plant material shall be cut or pruned back, in the method appropriate to the type of plant material and specific landscape intent, to promote dense, compact growth and optimal flowering.
3. Groundcover plantings are to be pruned as necessary to remove dead and/or injured twigs, branches and/or stems, and to keep the plants within the area of planting and from overrunning adjacent plantings.
4. Prior to the start of spring growth, all dead and/or dried stems, seed-heads, etc. from the previous winter are to be cut back and removed.
5. In fall, cut back perennials and ornamental grasses as necessary, with the exception of those to remain for winter interest.

3.9 STAKING, GUYING AND TYING:

A. Staking or guying of woody plant material: Woody plant material is only to be staked or guyed when out of plumb due to settling, wind damage, etc. or at the direction of the Owner Representative.

B. Staking and tying of herbaceous plant material:

1. Herbaceous plant material is to be staked and tied as necessary to keep plants upright and promote optimal plant health, growth and flowering.
2. Materials

a. Stakes are to be natural bamboo or other approved material, of sufficient thickness to adequately support the material being staked.
b. Tying material is to be natural twine or other approved material of inconspicuous color.

3. Installation and maintenance:

a. Stakes are to be installed as inconspicuously as possible. The final height is to be no taller than the material being staked; stakes are not to be visible above the adjacent plant material, once the material has achieved its final height.

b. Stakes are to be installed closely enough to each other to ensure that the tied material maintains a natural habit; the amount of material gathered into each tied area is to be no more than necessary. Staking of large groups of plants en masse will not be permitted.
c. Ties are to be installed as inconspicuously as possible.
d. Plant material is to be staked before becoming top-heavy or over-grown.
e. Stakes and ties are to be maintained intact as long as necessary to achieve the desired effect. When necessary, or as directed, stakes and tying materials are to be completely removed and disposed of appropriately.

3.10 PLACING SOIL IN PLANTERS

A. Place a layer of drainage gravel at least 4 inches (100 mm) thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 6 inches (150 mm) up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.

B. Fill planter with planting soil. Place soil in lightly compacted layers to an elevation of 1-1/2 inches (38 mm) below top of planter, allowing natural settlement.

3.11 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing unless noted otherwise.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.12 ORNAMENTAL AND NATIVE GRASS PLANTING

A. Remove plants from containers by inverting container, taking care not to damage plant material; or by cutting root mass with a knife on 4-sides to a depth of 1/2-inch (12.7-mm) and cut the bottom of root mass in same manner in an ‘X’ pattern. Loosen up root systems of container-grown plants.

B. Do not allow root tips to become damaged from exposure to air; keep growing root tips moist and covered. Plant as quickly as possible upon removal from containers.

C. Do not set plants too high or too low; plant so that plant crowns are just slightly above soil level. Thoroughly water plants upon planting, and maintain through substantial completion.

3.13 PERENNIAL PLANTING

A. Prepare planting beds for mass plant areas to achieve a slight crown. Loosen planting bed soil to a depth of 4- to 6-inches (101.6- to 152.5-mm).

B. Remove plants from containers by inverting container, taking care not to damage plant material. Split biodegradable containers. Loosen up root systems of container-grown plants.

C. Do not allow root tips to become damaged from exposure to air; keep growing root tips moist and covered. Plant as quickly as possible upon removal from containers.

D. Set plants in prepared beds so that plant crowns are just slightly above planting soil level. Thoroughly water plants upon planting, and maintain through substantial completion.

3.14 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Treelike Shrubs in Turf Areas: Apply mulch ring with minimum 36-inch (900-mm) radius around trunks or stems. Do not place mulch within 6 inches (150 mm) of trunks or stems.
2. Mulch in Planting Areas: Apply mulch over whole surface of planting area, and finish 1/2" below adjacent finish grades. Do not place mulch within 6 inches (150 mm) of trunks or stems.
3. Leafy stems of groundcover or vines shall not be buried under mulch material.
4. Plant material requiring differing depths of mulch which are present in one planting bed shall be mulched to each plant type's required depth; transitions between areas of differing depths of mulch shall be accomplished as smoothly as possible.

B. "Volcano" mulching, the practice of heaping mulch against the stems or trunks of plant material, is strictly forbidden. Plant material with bark or trunk damage due to this practice will be replaced by the Contractor, at his expense.

C. When adding mulch to existing tree rings or planting beds, old, decomposed mulch is to be removed as necessary to maintain the original soil grade; decomposed mulch shall not be allowed to build up so as to result in additional soil covering the plant roots.

D. In no case shall mulch come in contact with any part of trunk or root flare. There should be a minimum 6" offset from flare to mulch.

E. Excess mulch shall be removed and disposed of off-site. Contractor shall not over-mulch planting beds with excess mulch.

3.15 EDGING OF BEDS AND TREE RINGS

A. All tree rings and planting beds which border on lawn or turf areas are to be edged as necessary to maintain a clean, crisp appearance.

B. Edging is to be accomplished by hand with an edging hand-tool, or by using a rotating or vibrating blade power driven machine which produces a maximum 2" deep x 2" wide trench at the transition edge.

C. Edging machines which produce a cut deeper than 2" are not acceptable. The use of shovels as edging tools is not acceptable.

D. Final depth of all cut edges, whether done by hand or machine, is to be no more than 2".

E. All debris generated by edging activities is to be removed from adjacent surfaces.

## 3.16 WATERING

A. General

***Jennifer Draper***
*2019-05-23 16:39:00*
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Watering Section as CPD Requirements

1. Contractor shall provide sufficient, appropriate and on-go ensure the health and vigor of all plant material.
2. On-site water will be supplied by the CHA for watering pu poses where available. If on-site water is not available, it shall be the responsibility of th Contractor to provide water from his own source at no expense to the CHA. The Cont actor shall furnish hoses and other watering equipment as required for watering.
3. Contractor shall have the necessary city permits in orde to obtain water from city hydrants.
4. Watering equipment shall be of a type that will prevent or preclude damage to the plant materials and/or the finished surface of the planting beds.
5. Water shall be applied to beds and plant material in such a way as to prevent damage to or flooding of the areas being watered and/or adjacent surfaces.

B. Watering Rates

1. The following rates shall be applied by the Contractor to all plantings unless rainfall for that week's period is greater than 1/2" or as otherwise determined by the Architect.

    a. Shade trees are to receive 50 gallons of water per tree per week.
    b. Ornamental trees are to receive 40 gallons of water per tree per week.
    c. Shrubs 18 inches and greater in size are to be watered to a depth of 12" per week.
    d. Shrubs less than 18 inches in size are to receive enough water to thoroughly wet the entire depth of the root ball once per week.
    e. Annuals, perennials, ornamental grasses and other herbaceous plant materials are to be watered to a depth of 6", once per week minimum.

2. If specific plantings require more (or less) frequent watering to ensure proper root establishment and to maintain the health and vigor of the plants, the Contractor's watering schedule must be adjusted accordingly.
3. Written documentation of watering schedule shall be supplied to the CHA.

## 3.17 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

C. Devices are not to remain in place over the winter months and must be removed by November 15; if the plant material is still under warranty, they must be reinstalled by April 1.

3.18 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

D. Irrigate sufficiently to saturate root system and prevent soil from drying out.

E. Remove dead or broken branches and treat pruned areas or other wounds.

F. Neatly trim plants where necessary.

G. Immediately remove clippings after trimming.

H. Control growth of weeds:

1. Any weed one inch or taller, and/or which is clearly visible, within a planted area is to be removed immediately. Removal is to include the roots as well as top growth.
2. Weeds shall be removed mechanically or by hand.
3. As weeds are removed, excess soil is to be shaken off the roots and returned to the planting bed.
4. Woody weeds/weed trees growing in or through shrub or hedge plantings are to be removed cleanly at the base with either a pruning saw or pruners. Herbaceous weeds growing in or through shrub or hedge plantings are to be pulled from the roots. Shearing weeds “to height” during pruning operations will not be acceptable.
5. Use of pre-emergent herbicides and other chemical herbicide is permitted with the prior approval of the CHA’s Designated Representative.
6. All debris generated from weeding operations is to be properly disposed of at the end of each work day.

I. Apply herbicides in accordance with manufacturer's instructions.

J. Control insect damage and disease. Apply pesticides in accordance with manufacturer’s instructions.

K. Remedy damage from use of herbicides and pesticides.

L. Replace mulch when deteriorated.

M. Maintain wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

## 3.19 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

## 3.20 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off CHA's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

## 3.21 MAINTENANCE SERVICE

A. Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:

1. Maintenance Period: until the date of Substantial Completion.

3.22 ACCEPTANCE

A. Planting Acceptance: At Substantial Completion of the project, the Architect will inspect landscape work for acceptance.

1. Acceptance requires:

a. Plant material shall conform to drawings with respect to quantity, quality, size, species, and location, except those items accepted or revised in field by Architect.
b. Plant material shall be in healthy condition as defined under guarantee requirements below.
c. Items shall appear to be in general conformance with specifications.

3.23 GUARANTEE

A. Contractor shall guarantee for period of one year from the date of Substantial Completion, replacement of plants which have died, or are in distressed/dying condition, or which have failed to flourish in such manner that their usefulness or appearance has been impaired. Replace any tree with dead main leader or crown that is 25% or more dead.

1. Exclusions: Contractor shall not be liable for replacement cost of plants damaged by deicing compounds, fertilizers, pesticides or other materials not specified in Contract Documents or not applied by the landscaper, by relocating or removal by others, by acts of God, or by vandalism, and losses due to curtailment of water by local authorities.

B. Inspection of the CHA's Maintenance Operations:

1. During guarantee period, Contractor shall, from time to time, inspect watering, cultivation, and other maintenance operations carried on by the CHA with respect to such work, and promptly report to the CHA any methods, practices or operations considered unsatisfactory and not in accord with interests or good horticultural practices.
2. After each site visit during the guarantee period, the Contractor shall submit a written record of the visit, including any problems, potential problems, and any recommended corrective action.
3. Failure of Contractor to so inspect or report shall be construed as an acceptance of the CHA's maintenance operations, and Contractor shall not thereafter claim or assert that any defects which may later develop are result of such methods or practices or operations.

3.24 REPLACEMENT

A. Plants which die or require replacement during one-year guarantee period shall be replaced as soon as possible during following acceptable planting seasons:

1. Spring Replacement Season: All plants - when ground becomes workable to June 15.
2. Fall Replacement Season:

a. Deciduous plants - September 1 to November 15.
b. Evergreen plants - September 1 to November 1.

B. Procedure:

1. Dispose of plants off-site in legal manner.
2. Replacements shall be of same size and species as original plant unless otherwise approved by Architect.
3. Replacements shall be supplied and installed in accordance with specifications.

    a. Additional one-year guarantee for replacement plants shall begin on date of final acceptance of replacement plant material by Architect as documented in field report.

4. Replacement and Damages:

    a. Decisions of Architect for required replacements shall be conclusive and binding upon Contractor.
    b. Contractor shall be responsible for repairing damage to property also caused by defective workmanship and materials.

**END OF SECTION**

**SECTION 32 96 00**

**TRANSPLANTING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes transplanting non-nursery-grown trees.

B. Related Requirements:

1. Section 01 56 39 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 31 23 18.13 "Subtitle D Waste Disposal" for handling and disposal of soil wastes.
3. Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil" for handling and disposal of soil wastes.
4. Section 31 23 23 "Acceptance of Backfill, Top Soil, & CU Structural Soil" for handling and importation of all backfill.
5. Section 32 93 00 "Plants" for new trees from nursery-grown sources.

1.3 DEFINITIONS

A. General: See definitions in ANSI A300 (Part 6) and in ANSI Z60.1 pertaining to field-grown trees, except as otherwise defined in this Section.

B. Caliper: Diameter of a trunk as measured by a diameter tape a height 6 inches (150 mm) above the root flair for trees up to, and including, 4-inch (100-mm) size at this height; and as measured at a height of 12 inches (300 mm) above the root flair for trees larger than 4-inch (100-mm) size.

C. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape at a height 54 inches (1372 mm) above the ground line for trees with caliper of 8 inches (200 mm) or greater as measured at a height of 12 inches (300 mm) above the root flair.

D. Root-Ball Depth: Measured from bottom of trunk flare to the bottom of root ball.

E. Root-Ball Width: Measured horizontally across the root ball with an approximately circular form or the least dimension for non-round root balls, not necessarily centered on the tree trunk.

F. Root Flare: Also called "trunk flare." The area at the base of the tree's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

## 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to transplanting work include, but are not limited to, the following:

a. Construction schedule. Verify availability of materials, personnel, equipment, and unimpeded access needed to make progress and avoid delays.
b. Tree and plant protection.
c. Tree maintenance.
d. Arborist's responsibilities.

## 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each of the following:

1. Slow-Release Watering Device: One unit of each size required.

C. Pruning Schedule: Written schedule prepared by arborist detailing scope and extent of pruning each tree in preparation for and subsequent to transplanting.

1. Species and size of plant.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Seasonal limitations on pruning.
5. Preparatory Pruning: Time schedule and description of preparatory pruning to be performed.

a. Indicate time in months preceding the extraction of the tree.
b. Indicate diameter of root ball and depth of root pruning for each tree.

6. Description of root and crown pruning during and subsequent to transplanting.
7. Description of maintenance following pruning.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified tree-service firm and arborist.

B. Certification: From arborist, certifying that transplanted trees have been protected during construction and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From arborist, recommended procedures to be established by Owner for care and protection of trees after completing the Work.

1. Submit before completing the Work.

D. Existing Conditions: Documentation of existing trees indicated to be transplanted, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1. Use sufficiently detailed color photographs or video recordings. Color shall accurately depict hue condition of foliage and bark.
2. Include drawings and notations to indicate specific wounds and damage conditions of each tree designated to be transplanted.

E. Tree-Transplanting Program: Submit before work begins.

F. Tree-maintenance reports.

1.7 QUALITY ASSURANCE

A. Tree-Service Firm Qualifications: An experienced landscaping contractor or tree-moving firm that has successfully completed transplanting work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

1. Arborist Qualifications: Certified Arborist as certified by ISA or Licensed arborist in jurisdiction where Project is located.

B. Tree-Transplanting Program: Prepare a written plan by arborist for transplanting trees for the whole Project, including each phase or process, tree maintenance, and protection of surrounding materials during operations. Describe in detail the materials, methods, and equipment to be used for each phase of the transplanting work.

1. Include transplanting times appropriate for each species at the Project location unless otherwise indicated on Drawings or directed by Arborist.
2. Include a transplanting schedule for each species to be transplanted, coordinated with the Project schedule.
3. Include site plans clearly marked to show tree-moving routes from extraction to planting locations. Indicate proposed equipment, weight, and turning radii.
4. Show details of temporary protective barriers where needed.
5. Include diagrams showing clearances to utility lines and other encumbrances along route.
6. Include care and maintenance provisions and eventual removal of tree stabilization.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or trees.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery with appropriate certificates.

C. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy their natural shape.

D. Completely cover foliage when transporting trees while they are in foliage.

E. Handle trees by root ball. Do not drop trees.

F. Move trees after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after moving, set trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify final grade elevations and final locations of trees and construction contiguous with trees by field measurements before proceeding with transplanting work. Perform transplanting only after finish grades are established.

B. Seasonal Restrictions: Transplant trees during the following in-season periods:

1. Evergreen Trees: April 1 – July 1 and September 1 - November 1
2. Deciduous Trees: April 1 – July 1 and September 1 - November 1

C. Weather Limitations: Proceed with transplanting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Do not transplant during excessively wet or frozen conditions. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

D. The work shall not occur in the presence of standing water, mud, snow, or frozen subgrade conditions. Work shall not occur while precipitation is occurring or during excessive winds, or when temperatures are outside the limits specified in this specification. Work completed during these conditions will be rejected.

E. Coordination with Turf Areas (Lawns): Perform transplanting before planting turf areas unless otherwise indicated.

1. When transplanting after planting turf areas, protect turf areas, and promptly repair damage caused by transplanting operations.

F. Coordination with Planting Beds: Perform transplanting before planting bedded areas unless otherwise indicated.

1. When transplanting after planting bedded areas, protect bedding plants, and promptly repair damage caused by transplanting operations.

1.10 WARRANTY

A. Installer's Special Warranty: Tree-service firm agrees to repair or replace trees and related materials that fail within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth except for defects resulting from abuse, lack of adequate maintenance, or neglect by the CHA, or incidents that are beyond Contractor's control.
b. Death and unsatisfactory growth is defined as more than 25 percent dead or in an unhealthy condition or failure to meet general performance requirements at end of warranty period.
c. Structural failures including trees falling or blowing over.
d. Faulty performance of materials and devices related to tree plantings including tree stabilization and watering devices.

2. Warranty Periods from Date of Substantial Completion:

a. Trees: 12 months.

3. Include the following remedial actions as a minimum:

a. Remove dead trees and trees with unsatisfactory growth at end of warranty period; replace when directed.
b. A limit of one replacement of each tree will be required except for losses or replacements due to failure to comply with requirements.
c. Replace materials and devices related to tree plantings.
d. Provide extended warranty for period equal to original warranty period, for replaced trees.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Transplanted trees shall be healthy and resume vigorous growth within one year of transplanting without dieback due to defective extracting, handling, planting, maintenance, or other defects in the Work.

2.2 PLANTING MATERIALS

A. Backfill Soil: Excavated soil mixed with planting soil of suitable moisture content and granular texture for placing and compacting in planting pit around tree, and free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

1. Mixture: Well-blended mix of two parts excavated soil to one part planting soil.

## 2.3 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring 8 inches (200 mm) in diameter and 48 inches (1200 mm) long, treated with specified wood preservative treatment by pressure process.
3. Flexible Ties: Wide rubber or elastic bands or straps.
4. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch (2.7 mm) in diameter.
5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
6. Guy Cable: Five-strand, 3/16-inch- (4.8-mm-) diameter, galvanized-steel cable, fitted with zinc-coated 3/8-inch (10-mm) galvanized eyebolts at ends.
7. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.
8. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by tree stem; sized as indicated and according to manufacturer's written instructions.

B. Root-Ball-Stabilization Materials:

1. Upright Stakes and Horizontal Hold-Down: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated; stakes pointed at one end.
2. Wood Screws: Hot-dip galvanized or stainless steel.
3. Proprietary Root-Ball-Stabilization Devices: Proprietary at- or below-grade stabilization systems to secure each new planting by root ball; sized according to manufacturer's written instructions unless otherwise indicated.

## 2.4 WATERING DEVICES

A. Slow-Release Watering Device: Standard product manufactured for drip-irrigation of plants and emptying its water contents over a period of 2 to 9 hours; manufactured from UV-light stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

## 2.5 MISCELLANEOUS PRODUCTS

A. Organic Mulch: Shredded hardwood as specified in Section 32 93 00 "Plants."

B. Burlap: Non-synthetic, biodegradable.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross transplanting areas.

B. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

1. Soil disposal shall be completed in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal" or Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," as applicable.

D. Do not install plantings where depth of soil over underground construction, obstructions or rock is insufficient to accommodate roots or where pockets in rock or impervious soil will require drainage. Where such conditions encountered in excavation planting areas and where stone, boulders or other obstruction cannot be broke or removed by hand methods and where trees to be planted found under overhead wires, bring to the attention of the Architect. Alternate locations for planting may be designated by Architect.

E. Verify location of underground utilities with appropriate sources prior to construction. Contact D.I.G.G.E.R. at least 48 hours before commencing with construction operations. Repair damaged utilities.

F. Conflicts with utilities shall be called to the Architect’s attention before proceeding with work. Alternate locations for planting may be designated by Architect.

G. Confirm that utility work has been completed per the drawings.

H. Remove rock or other underground construction and drain planting areas only when approved by Architect.

I. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to transplanting work and tree protection and health.

J. Verify that prepared subsoil is ready to receive work.

K. Proceed with transplanting only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, other facilities, turf areas, and other plants and planting areas from damage caused by transplanting operations.

B. Locate and clearly identify trees for transplanting. Tie a 1-inch (25-mm) blue-vinyl tape around each tree at 54 inches (1372 mm) above the ground.

C. Lay out individual transplant locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before transplanting. Make minor adjustments as required.

## 3.3 PREPARATORY PRUNING

A. Root Pruning: Perform preparatory root pruning under direction of arborist as far in advance of extracting each tree as the Project Schedule allows.

1. Dig exploratory pits or trench by hand or with air spade around perimeter of tree at indicated root-ball width to determine locations of main lateral roots.
2. Dig trench by hand or with tree spade around perimeter of tree at indicated root-ball width to the depth of the root system. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
3. Root-Ball Width: Minimum 9 inches (229 mm) of root-ball diameter, or least dimension for non-round root balls, for each inch (25 mm) of tree caliper being transplanted.
4. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking.
5. Use narrow-tine spading forks to comb soil to expose roots with minimal damage to root system.
6. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
7. Do not paint or apply sealants on cut root ends.
8. Backfill trench with excavated soil.

B. Crown Pruning (Tip Pruning):

1. Do not perform preparatory crown pruning (tip pruning).
2. Perform preparatory crown pruning as shown on Drawings, under direction of arborist. Follow procedures as specified in "Crown Pruning" Article.

## 3.4 EXCAVATION AND PLANTING EQUIPMENT

A. Tree Spade: Track-mounted mechanized tree mover; sized according to manufacturer's size recommendation for each tree being transplanted.

## 3.5 EXCAVATING PLANTING PITS

A. General: Excavate under supervision of the arborist.

1. Excavate planting pits or trenches with sides sloping. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately two times as wide as root ball.
3. Keep excavations covered or otherwise protected until replanting trees.

B. Subsoil and topsoil removed from excavations may not be used as planting soil unless otherwise indicated.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.

D. Seepage: Notify Architect if subsoil conditions evidence unexpected water seepage into tree-planting pits.

E. Drainage: Fill planting pit or trench with 6 inches (152 mm) of water and time the infiltration rate of the soil. If the drainage rate is less than 0.25 inch (6 mm) per hour, notify Architect to determine need for subsurface drainage.

## 3.6 EXTRACTING TREES

A. General: Extract trees under supervision of the arborist.

B. Orientation Marking: Mark the north side of each tree with non-permanent paint before extracting.

C. Root-Ball Width: Minimum 10 inches (250 mm) of root-ball diameter, or least dimension for non-round root balls, for each inch (25 mm) of tree caliper being transplanted.

D. Root-Ball Depth: As determined by the arborist for each species and size of tree and for site conditions at original and planting locations.

E. Digging:

1. Dig and clear a pit by hand or with tree spade to the depth of the root system. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Use narrow-tine spading forks to comb soil to expose roots with minimal damage to root system.
3. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking.

4. Cut exposed roots manually with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not paint or apply sealants on cut root ends.
5. Construct box tight against root system sides and bottom as pit is dug. Brace and support box to prevent breaking of root ball.
6. Temporarily support and protect exposed roots from damage until they are permanently redirected and covered with soil. Cover roots with burlap and keep them moist until planted.

F. Extracting with Tree Spade: Use the same tree spade to extract the tree as will be used to transport and plant the tree.

1. Do not use tree spade to move trees larger than the manufacturer's maximum size recommendation for the tree spade being used.
2. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

## 3.7 PLANTING

A. Planting Standard: Perform planting according to ANSI A300 (Part 6) unless otherwise indicated.

B. Before planting, verify that root flare is visible at top of root ball. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

C. Ensure that root flare is visible after planting.

D. Remove injured roots by cutting cleanly; do not break. Do not paint or apply sealants on cut root ends.

E. Orientation: Position the tree so that its north side, marked before extracting, is facing north in its new location.

F. Set tree plumb and in center of planting pit with top of root flare visible above adjacent finish grades.

1. Use specified backfill soil for backfill.
2. If area under the tree was initially dug too deep, add backfill to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
3. After placing some backfill around root ball to stabilize plant, begin backfilling.
4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Redirect exposed root ends downward in backfill areas where possible. Hand-expose roots as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.

6. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended by arborist. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
7. Continue backfilling process. Water again after placing and tamping final layer of soil.

G. Planting with Tree Spade: Use the same tree spade for planting as was used to extract and transport the tree. Do not use tree spade for trees larger than the manufacturer's maximum size recommendation for the tree spade being used.

H. Slopes: When planting on slopes, set the tree so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

## 3.8 CROWN PRUNING

A. Prune branches as shown on Drawings, under direction of arborist.

1. Prune to remove only injured, broken, dying, or dead branches. Do not prune for shape.
2. Do not remove or reduce living branches to compensate for root loss caused by cutting root system or to improve natural tree form.
3. Pruning Standards: Perform pruning according to ANSI A300 (Part 1).

B. Unless otherwise directed by arborist and acceptable to Architect, do not cut tree leaders.

C. Cut branches with sharp pruning instruments; do not break or chop.

D. Do not paint or apply sealants to wounds.

E. Provide subsequent maintenance during Contract period as recommended by arborist.

F. Chip removed branches and dispose of off-site.

## 3.9 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated on Drawings or directed by Arborist.

1. Upright Staking and Tying: Stake only as required to prevent wind tip out. Use a minimum of three stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend one-third of trunk height above grade. Set stakes vertical and space to avoid penetrating root balls or root masses.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings or directed by Arborist.

1. Site-Fabricated Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.

    a. Securely attach guys to stakes 30 inches (760 mm) long, driven to grade. Adjust spacing to avoid penetrating root balls or root masses. Provide turnbuckle or compression spring for each guy wire and tighten securely.
    b. For trees more than 6 inches (150 mm) in caliper, anchor guys to wood deadmen buried at least 36 inches (900 mm) below grade. Provide turnbuckle or compression spring for each guy wire and tighten securely.
    c. Support trees with bands of flexible ties at contact points with tree trunk and reaching to a turnbuckle or compression spring. Allow enough slack to avoid rigid restraint of tree.
    d. Support trees with guy cable or multiple strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to a turnbuckle or compression spring. Allow enough slack to avoid rigid restraint of tree.
    e. Attach flags to each guy wire, 30 inches (760 mm) above finish grade.
    f. Paint turnbuckles or compression springs with luminescent white paint.

2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

C. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated on Drawings **or directed by Arborist**.

1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.

    a. Install stakes of length required to penetrate at least [18 inches (450 mm) below bottom of backfilled excavation. Saw stakes off at horizontal stake.
    b. Install screws through horizontal hold-down and penetrating at least 1 inch (25 mm) into stakes. Predrill holes if necessary to prevent splitting wood.
    c. Install second set of stakes on other side of root trunk for larger trees as indicated.

2. Proprietary Root-Ball-Stabilization Device: Install root-ball-stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

## 3.10 MULCHING

A. Organic Mulch: Apply 3-inch (75-mm) average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.11 WATERING

1. Contractor shall provide sufficient, appropriate and on-going watering as necessary to ensure the health and vigor of all plant material.
2. On-site water will be supplied by the CHA for watering purposes where available. If on-site water is not available, it shall be the responsibility of the Contractor to provide water from his own source at no expense to the CHA. The Contractor shall furnish hoses and other watering equipment as required for watering.
3. Contractor shall have the necessary city permits in order to obtain water from city hydrants.
4. Watering equipment shall be of a type that will prevent or preclude damage to the plant materials and/or the finished surface of the planting beds.
5. Water shall be applied to beds and plant material in such a way as to prevent damage to or flooding of the areas being watered and/or adjacent surfaces.

B. Watering Rates

1. The following rates shall be applied by the Contractor to all plantings unless rainfall for that week's period is greater than 1/2" or as otherwise determined by the Architect.

    a. Shade trees are to receive 50 gallons of water per tree per week.
    b. Ornamental trees are to receive 40 gallons of water per tree per week.

2. If specific plantings require more (or less) frequent watering to ensure proper root establishment and to maintain the health and vigor of the plants, the Contractor's watering schedule must be adjusted accordingly.
3. Written documentation of watering schedule shall be supplied to the CHA.

3.12 INSTALLING SLOW-RELEASE WATERING DEVICE

A. Provide one device for each tree.

B. Place device on top of the mulch at base of tree and fill with water according to manufacturer's written instructions.

C. Devices are not to remain in place over the winter months and must be removed by November 15; if the plant material is still under warranty, they must be reinstalled by April 1.

3.13 CLEANUP AND PROTECTION

A. During transplanting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect trees from damage due to transplanting operations and operations of other contractors and trades. Maintain protection during transplanting and maintenance periods. Treat, repair, or replace damaged plantings.

C. After planting and before Substantial Completion, remove tags, markings, tie tape, labels, wire, burlap, and other debris from transplanted trees, planting areas, and Project site.

D. Except for materials indicated to be recycled or retained on the Owner's property, remove excess excavated material, waste materials, displaced plants, trash, and debris, and dispose of them off Owner's property in accordance with Section 31 23 18.13 "Subtitle D Waste Disposal" or Section 31 23 18.14 "Clean Construction or Demolition Debris and Uncontaminated Soil," as applicable.

E. Transport surplus satisfactory soil to designated storage areas on CHA's property. Stockpile or spread soil as directed by Architect.

## 3.14 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide tree maintenance by skilled employees of tree-service firm. Begin maintenance immediately after trees are installed and continue until plantings are healthy and well established but for not less than maintenance period below.

1. Maintenance Period: until the date of Substantial Completion.

## 3.15 GUARANTEE

A. Contractor shall guarantee for period of one year from the date of Substantial Completion, replacement of plants which have died, or are in distressed/dying condition, or which have failed to flourish in such manner that their usefulness or appearance has been impaired. Replace any tree with dead main leader or crown that is 25% or more dead.

1. Exclusions: Contractor shall not be liable for replacement cost of plants damaged by deicing compounds, fertilizers, pesticides or other materials not specified in Contract Documents or not applied by the landscaper, by relocating or removal by others, by acts of God, or by vandalism, and losses due to curtailment of water by local authorities.

B. Inspection of the CHA’s Maintenance Operations:

1. During guarantee period, Contractor shall, from time to time, inspect watering, cultivation, and other maintenance operations carried on by the CHA with respect to such work, and promptly report to the CHA any methods, practices or operations considered unsatisfactory and not in accord with interests or good horticultural practices.
2. After each site visit during the guarantee period, the Contractor shall submit a written record of the visit, including any problems, potential problems, and any recommended corrective action.
3. Failure of Contractor to so inspect or report shall be construed as an acceptance of the CHA's maintenance operations, and Contractor shall not thereafter claim or assert that any defects which may later develop are result of such methods or practices or operations.

## 3.16 REPAIR AND REPLACEMENT

A. General: Repair or replace transplanted trees and other plants indicated to remain or be relocated that are damaged by construction operations, in a manner recommended by the arborist and approved by Architect.

1. Submit details of proposed pruning and repairs.
2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to arborist's written instructions.
3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.

B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the guarantee period, or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

C. Plants which die or require replacement during one-year guarantee period shall be replaced as soon as possible during following acceptable planting seasons:

1. Spring Replacement Season: when ground becomes workable to June 15.
2. Fall Replacement Season:

    a. Deciduous plants - September 1 to November 15.
    b. Evergreen plants - September 1 to November 1.

D. Procedure:

1. Dispose of plants off-site in legal manner.
2. Provide new trees of the same size and species as those being replaced for trees measuring less than 6 inches in caliper size.
3. If tree required to be replaced is more than 6 inches in caliper size, measured 12 inches above grade, provide new tree of 6-inch caliper size and of a species selected by Architect.
4. Replacements shall be supplied and installed in accordance with specifications.

    a. Additional one-year guarantee for replacement plants shall begin on date of final acceptance of replacement plant material by Architect as documented in field report.

5. Replacement and Damages:

    a. Decisions of Architect for required replacements shall be conclusive and binding upon Contractor.
    b. Contractor shall be responsible for repairing damage to property also caused by defective workmanship and materials.

**END OF SECTION**

# SECTION 33 10 00

# WATER SERVICE

## PART 16 - GENERAL

16.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

16.02 SUMMARY

A. Section Includes:

Water service system as indicated and specified
Ductile Iron Pipe (DIP): Ductile or other slip-joint connected pipe is to be made electrically continuous with exothermically welded bonds across joints. Dielectrics are to be installed at street connection.
Joints
Fittings
Gaskets
Gate Valves
Polyethylene Encasement

B. Related Requirements:

Section 31 22 14 “Earthwork”.
Section 31 23 33 “Excavating Backfilling Compacting for Utilities”.
Section 31 13 13 “Concrete Paving”.
Section 33 30 00 “Sewerage and Drainage”.

16.03 SUBMITTALS

A. Product Data: Provide product data for each product specified.

B. Manufacturers literature, installation instructions, dimensions, materials, standards, certifications and guarantees.

16.04 QUALITY ASSURANCE

A. Perform Work in accordance with Illinois Department of Transportation (IDOT) "Standard Specifications for Road and Bridge Construction".

Measurement and payment provisions and safety program submittals included in IDOT Standard Specifications do not apply to this Section.

## PART 17 - PRODUCTS

17.01 MATERIALS

A. Ductile Iron Pipe

Ductile iron pipe must conform to the requirements of AWWA C151 and with the additions or substitutions specified in this Section.

Pipe bells must be designed to provide a watertight joint without leakage and must be capable of withstanding pressures exceeding those that will rupture pipe of this class and thickness without requiring additional jointing material.

Electrical conductivity must be provided at each joint on all push-on and mechanical jointed pipe 16-Inches in diameter and smaller, to facilitate thawing of frozen pipe and building water services. Conductivity is to be accomplished by installing serrated silicon wedges as recommended or supplied by the pipe manufacture. The use of lead tip gaskets will not be allowed.

All pipes must be manufactured so that where a cut is made at any point along the barrel, the cut end will fit properly into a standard mechanical joint bell and be drip tight at hydrostatic test pressure.

Exterior of pipe must be coated with a petroleum asphaltic material in conformance with AWWA C110, Section 10-10. Interior of pipe must be cement lined in accordance with AWWA C104.

Pipe thickness and classes must conform to standards shown in Table A.

Table A Pipe Thickness and Class

| Pipe Size | Nominal Wall Thickness | Thickness Class |
|---|---|---|
| 3-inch | 0.34-inch | 54 |
| 4-inch | 0.38-inch | 55 |
| 6-inch | 0.40-inch | 55 |
| 8-inch | 0.45-inch | 56 |
| 10-inch | 0.47-inch | 56 |
| 12-inch | 0.49-inch | 56 |

B. Joints

Lead joints are not to be used under any circumstances.

Pipe joints must be push-on type joints unless otherwise noted on the drawings or specified here. Push-on type joints must conform to AWWA C111.

Restrained joints when specified are to meet the following requirements:

a. Mechanical joint pipe with mechanical joint restraint glands. Mechanical joints must conform to AWWA C110. Gaskets must conform to Section 2.4 of this specification.
b. Restrained joint pipe with manufactured weldment, field weldments or manufactured locking rings, locking segments and runner retainers and appurtenances conforming to AWWA C110. Acceptable products are Super-Lock Pipe manufactured by Clow Water Systems Company; FlexRing Pipe or Lok-Ring Pipe manufactured by American Ductile Iron Pipe; or TRFLEX manufactured by United States Pipe and Foundry Company.

Mechanical Joint Restraint Glands.

c. Provide restraint glands at all mechanical joints.
d. Restraint glands must be designed for use with the standardized mechanical joint bell pipe conforming to AWWA C110 and AWWA C153. Restraint is to be incorporated into the design of the gland. Acceptable products for this use are Mega Lugs manufactured by EBAA Iron Works; Uniflange manufactured by Ford Meter Box; or Star Grip manufactured by Star Pipe Products.
e. Restraint is to be accomplished using multiple, wedge style restraints. Proper actuation of the wedges is to be ensured with torque limiting twist off nuts.
f. Glands 3-Inches through 16-Inches are to be pressure rated at 350-psi; glands 18-Inch through 48-Inch are to be rated at 250 psi.
g. The gland body and restraint components are to be made from ductile iron conforming to ASTM A536, 65-45-12. Ductile iron wedges are to be heat-treated within a range of 370 to 470 BHN.
h. The joint is to be capable of full deflection during assembly and joint deflection after assembly
i. Provide glands with minimum weights and number of wedges as shown in Table B.
j. Retainer glands are not acceptable.

Table B – Minimum Weight & Number of Wedges Per Restrained Joint

| Pipe Size | Number of Wedges | Minimum Weight |
|---|---|---|
| 3-inch | 2 | 6.0 lbs |
| 4-inch | 2 | 7.0 lbs |
| 6-inch | 3 | 11.0 lbs |
| 8-inch | 4 | 14.5 lbs |
| 10-inch | 6 | 23.0 lbs |
| 12-inch | 8 | 28.5 lbs |

Flanged joints must conform to the following:

k. Flanged joints must conform to AWWA C115. Flanges must be the long hub type, screwed on the threaded end of the pipe in the shop. There must be no leakage

through the pipe threads. The flanges must be designed to prevent corrosion of the threads from the outside.

l. Flanges must be drilled according to the requirements of ANSI/ASME B16.1, Class 125 unless special drilling is called for on the Drawings or specified. Bolt holes must be equally spaced, drilled smooth and true. When stud bolts are used flanges must be drilled and tapped to accommodate the studs.

m. The face of the screwed-on flange and plain-end of the pipe must be accurately refaced together, at right angles to the pipe axis. After facing and drilling, the face of the screwed-on flange must immediately be covered with an appropriate rust-preventive coating.

n. Flanged joints must be secured with either bolts and nuts, or stud bolts with a nut. Bolts, stud bolts, and nuts must meet the requirements of ASTM A307, Grade B. Bolts and stud bolts must conform to ANSI/ASME B18.2.1. Nuts must conform to ANSI/ASME B18.2.2. All bolts, stud bolts, and nuts must be primed with bitumastic paint after the bolts and nuts have been installed and tightened.

o. Gaskets must conform to Section 2.4 of this specification.

C. Fittings

Fittings to be furnished and installed as specified or shown on the Drawings must be mechanical joint, ductile iron in accordance with AWWA C110. Laying length of mechanical joint castings must be as shown in AWWA C110. Wall thickness and allowable variation in the thickness of mechanical joint castings must conform to AWWA C110 and have a 250-psi pressure rating.

Compact fittings may not be used.

Plain ends of mechanical joint fittings must be beveled and gauged to properly seat in push-on joint bells.

The fittings must be smooth and free from defects of every nature that would make them unfit for the use that they were intended. Plugging of fittings is not allowed. Repairing of defects by welding will be allowed if such repairs will not adversely affect the serviceability of the fittings or their ability to meet the strength requirements of the referenced AWWA standards.

All castings must be coated inside and outside with a petroleum asphaltic material in conformance with Section 4.3 of AWWA C110. A cement-mortar lining is not required.

Flanged fittings must conform to AWWA C110 and have a 150-pound per square inch pressure rating.

D. Gaskets

All gaskets for pipe, fittings and appurtenances must be vulcanized natural or vulcanized synthetic rubber, non-porous, free of foreign materials and visible defects. Recycled rubber may not be used.

When soil conditions do not permit the use of natural or synthetic rubber gaskets, all gaskets for pipe, fittings and appurtenances must be Nitrile (acrylonitrile butadiene), nonporous, free of foreign materials and visible defects.

Gaskets for flanged joints must be of the ring type, 1/16-Inch thick, and meet the requirements of ANSI Standard B16.21. Acceptable manufactures for gaskets type as manufactured by the Crane Company; Garlock Packing Company; or U.S. Rubber Company.

Gaskets must be stored in a cool place and protected from light, heat, oil, or grease until installed. Any gasket showing signs of cracking, weathering, abrasion or other deterioration will be rejected.

E. Gate Values

All gate valves are to be Chicago Standard Gate Valves of the size shown on the drawings that are designed, manufactured, tested, and inspected in accordance with AWWA C500, and in accordance with the exceptions noted here. All valves are to be delivered fully assembled. The following characters must be cast in ½-inch letters on the bonnet of each valve:

a. Chicago
b. Year of Manufacture
c. Manufacture's Name

Gate valves must be of mechanical joint type double disk and in the following sizes: 4-Inch, 6-Inch, 8-Inch, 12-Inch, and 16-Inch. Larger size valves must be of a butterfly style.

Material used must meet the requirements as to physical and chemical properties, as specified in this Section.

Valves found to contain defects such as blowholes, shrinkage or slag holes, cold shuts, or cracks will be rejected.

The thickness of metal in castings, whose standard thickness is less than 0.8-Inch, must not be more than 0.08-inch less than the standard thickness. The deficiency in thickness of castings, whose standard thickness is 0.8-inch or more, must not exceed 10% of the standard thickness. The above allowable deficiencies in thickness, however, must not extend over more than one-half of the area of the casting.

After being cleaned and tested, every assembled valve and all metallic parts must be coated inside and outside with coal tar pitch varnish. It must produce a smooth and non-tacky coating tough and tenacious when cold and not brittle nor with any tendency to scale off.

The brass castings must comply with ASTM B584, Copper Alloy UNS No. C83600.

The bronze in the valve stem and in the stem, nut must be manganese bronze, complying with ASTM B584, Copper Alloy UNS No. C86700. Stem seals are to be double O-rings complying with ASTM D2000 and ASTM A568.

The gaskets used between the flanges must be fully faced, 1/32-inch thick and made of heavy-duty, asbestos-free, fiber composition, suitable for water service.

Bolts and nuts must be made of cast iron or steel. Heads of seal plate bolts must conform to the dimensions shown on the Drawings (an alternate of hex or square head bolt is acceptable) while all other requirements of seal plate bolts must conform to Federal Specification FF-B-575C and nuts must conform to FF-N-836E. Heads of bolts must be unfinished, and nuts must be semi-finished. Both bolts and nuts must be hot dipped galvanized as specified in the applicable Federal Specification.

The valves herein specified must be furnished complete with mechanical joint accessories. The mechanical joint accessories must consist of mechanical joint thrust restraint glands, rubber gaskets, and tee head bolts and hex nuts, all conforming to AWWA C110. Dimensions and tolerances for mechanical joints must conform to table 1of AWWA C110.

It will be the manufacturer's responsibility to provide the patterns and gauges necessary to perform the work to be done hereunder. The Department will not furnish these items.

All valves must open by turning the operating stem clockwise.

Operating nuts must be 2 ½-Inches square at the base of the nut.

F. Polyethylene Encasement

Polyethylene encasement material must be either 8-mil, low density or 4-mil, cross-laminated, high-density polyethylene tubing in accordance with AWWA C105.

## PART 18 - EXECUTION

### 18.01 INSTALLATION

A. All ductile iron pipe, fittings, and appurtenances must be installed in accordance with the manufacturer's recommendations and requirements.

B. All pipe, fittings, and accessories must be delivered, unloaded, strung, and laid as specified here.

C. The water mains must be laid with depths of cover as indicated under Article 3.10 of this specification, unless otherwise shown on the drawings. The pipes must be laid true to line and grade.

D. Fittings as specified must be used where shown on the drawings and where grade or alignment changes require offsets greater than those recommended by the pipe manufacturer.

### 18.02 TRANSPORTATION, DELIVERY AND STORAGE

A. Every precaution must be taken to prevent damage to the pipe during transportation and delivery. Pipe ends must be sealed with caps or by another suitable method upon taking delivery from the supplier. Extreme care must be taken in loading and unloading the pipe and fittings. Such work must be done slowly with skids or suitable power equipment and the pipe must be always under complete control. Under no conditions may the pipe be dropped, bumped, dragged, pushed, or moved in any way that will cause damage to the pipe. When handling the pipe with a crane, a suitable pipe hook or rope sling around the pipe must be used. Under no condition may the sling be allowed to pass through the pipe unless adequate measures are taken to prevent damage to the pipe ends and lining.

B. If in the process of transportation, handling, or installation, any pipe or fitting is damaged, such pipe or fitting must be replaced by the Contractor and be considered incidental to the construction and no additional payment will be allowed.

C. The Contractor must store pipe in a manner that will prevent damage. Pipe must be placed on wooden timbers or another suitable support on level ground. The Contractor must prevent the pipe from rolling.

### 18.03 PREPARATION FOR LAYING PIPE

A. Materials, coatings, and linings must be as specified herein or as shown on drawings. Water mains and services must be installed where shown on the drawings. Installation must be in accordance with standards as recommended by the pipe manufacturer, and as specified herein.

B. Proper and suitable tools and appliances for the safe and convenient cutting, handling, and laying of the pipe and fittings must be used.

C. Before placing, all pipe and fittings must be thoroughly examined for defects and no piece may be installed which is known to be defective. If defects are discovered after pipe or fittings have been installed, the Contractor must remove the defective pipe and/or fitting and replace it with a sound one at his expense.

D. The pipe and fittings must be thoroughly cleaned before they are laid and must be kept clean until they are accepted in the finished work. Care must be exercised to avoid leaving bits of wood, dirt, rock, and other foreign particles in the pipe. If any such materials are discovered before the final acceptance of the work, they must be removed and the pipe and fittings replaced, if necessary. All pipes must be kept absolutely clean during construction and must be stopped off with night plugs at the end of each day's work. Exposed ends of uncompleted lines and existing water mains and services cut and not abandoned must be capped or otherwise temporarily always sealed when pipe laying is not in progress.

E. When cutting ductile iron pipe, it must be neatly cut perpendicular to the longitudinal axis of the pipe without damaging the pipes lining or coating or jointing surface area.

## 18.04 LAYING WATER SERVICE PIPE

A. The Contractor shall do all excavation of whatever unclassified material is encountered to the depths established by Contractor. Trench depths, not established, shall be figured to allow a minimum cover over the top of the pipe as dictated herein.

In open cut excavation, the Contractor shall keep the trench width at the top of the pipe not wider than established, unless the angle of repose of the soil is unsuitable.

B. All pipelines must be laid in trench excavations on bedding or other foundations, as shown on the drawings and as specified herein. The pipe must be properly secured against movement and pipe joints must be made in the excavation as required. Pipes must have solid bearing throughout their entire length.

C. At locations where pipe thrust is anticipated to occur, pipe and fittings must be anchored or restrained as shown on the drawings.

D. Pipe lying will be permitted only in dry trenches having a stable bottom. The contractor shall remove, by pumping or other means, any water accumulated in the excavation and keep the trench dry during the pipe laying period. The contractor shall provide adequate pumps, well points, or other dewatering method at no extra cost to the CHA. If the trench bottom is unsuitable for the pipe's foundation, the kind of stabilization to be utilized will be ordered in writing.

E. The Contractor must take such required precautions to prevent flotation of the new pipeline.

## 18.05 HORIZONTAL SEPARATION - WATER MAINS AND SEWERS

A. The work under this section will be performed in accordance with applicable sections of the City of Chicago Building and Plumbing Code, latest edition.

B. Water mains shall be located at least ten feet horizontally from any existing or proposed drain, storm sewer, sanitary sewer, combined sewer, or sewer service connection.

C. Water mains may be located closer than ten feet to a sewer line when:

Local conditions prevent a lateral separation of ten feet; and
The water main invert is at least 18 inches above the crown of the sewer; and

The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located to one side of the sewer.

D. When it is impossible to meet (1) or (2) above, both the water main and drain or sewer shall be constructed of slip-on mechanical joint cast or ductile iron pipe. The drain or sewer shall be pressure tested to the maximum expected surcharge head before backfilling.

18.06 VERTICAL SEPARATION - WATER MAINS AND SEWERS

A. A water main shall be separated from a sewer so that its invert is a minimum of 18 inches above the crown of the drain or sewer whenever water mains cross storm sewers, vertical separation shall be maintained for that portion of the water main located within ten feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.

B. Both the water main and sewer shall be constructed of slip-on or mechanical joint cast or ductile iron pipe, prestressed concrete pipe, when:

It is impossible to obtain the proper vertical separation as described in (A) above; or
The water main passes under a sewer or drain.

C. A vertical separation of 18 inches between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and creaking the water main, as shown on the plans, or as approved by the Engineer.

D. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least ten feet.

18.07 ASSEMBLY OF FLANGED JOINTS

A. Flanged joints must be made with bolts or bolt studs with nuts as specified in Section 2.2 of this specification.

B. Tighten flange bolts as recommended by the gasket manufacturer to ensure an evenly compressed gasket and leak tight joint.

C. After the bolts and nuts have been properly installed, tightened, and cleaned, prime them with bitumastic paint.

18.08 ASSEMBLY OF MECHANICAL JOINTS

A. Thoroughly brush the surfaces with which the rubber gasket meets a wire brush just prior to assembly of the joint. Brush lubricant over the gasket and the plain end just prior to installation. In making up mechanical joints, the spigot must be centered in the bell.

B. The gasket and gland must be placed in position, the bolts inserted, and the nuts tightened finger tight. The nuts must be tightened by means of a torque wrench in such a manner that the gland must be brought up evenly into the joint.

C. Joints are to be made up to allow electrical continuity from one pipe to another by installing wedges as specified in Article 2.1, paragraph C of this specification and are to be installed in the following manner:

Use two (2) wedges per joint for 3-Inch to 12-Inch diameter pipes. Wedges must be placed on opposite sides of the joint at an equal distance apart (9 and 3 o'clock positions) around the joint.

Use four (4) wedges per joint for 16-inch to 24-inch diameter pipes. Wedges must be installed side by side in pairs placed on opposite sides of the joint at an equal distance apart (9 and 3 o'clock positions) around the joint.

Use six (6) wedges per joint for pipes larger than 24-inches in diameter only if building services are directly connected to the main. Wedges must be installed side by side in pairs 120 degrees apart at the 12, 4, and 8 o'clock positions around the joint.

The following range of bolt torques must be applied as specified in Table C. If sealing is not obtained at the maximum torque requirements listed in Table C, the joint must be disassembled, thoroughly cleaned, and reassembled.

Table C – Bolt Torque Requirements

| Bolt Size | Torque Range |
|---|---|
| 5/8 - inch | 45-60 ft-lbs |
| 3/4 - inch | 75-90 ft-lbs |
| 1 - inch | 85-100 ft-lbs |
| 1 ¼ inches | 105-120 ft-lbs |

18.09 ASSEMBLY OF PUSH-ON RUBBER GASKET JOINTS

A. Thoroughly brush the gasket seat in the bell with a wire brush and wipe the gasket and gasket seat with a cloth. Place the gasket in the socket with the large round end entering first so that the groove fits over the bead in the seat. Apply a thin film of NSF 61 approved joint lubricant to the inside surface of the gasket that will meet the entering pipe.

B. Thoroughly brush the plain end of the pipe with a wire brush and placed it in alignment with the bell of the pipe to which it is to be joined. Make up the joint by exerting sufficient force on the entering pipe so that its plain end is moved past the gasket until it contacts the base of the socket.

C. Joints are to be made up to provide electrical continuity from one pipe to another by installing wedges as specified in Article 2.1, paragraph C of this specification and are to be installed in the following manner: 1. Use two (2) wedges per joint for 3-Inch to 12-Inch diameter pipes. Wedges must be placed on opposite sides of the joint at an equal distance apart (9 and 3 o'clock positions) around the joint. 2. Use four (4) wedges per joint for 16-Inch to 24-Inch diameter pipes. Wedges must be installed side by side in pairs placed on opposite sides of the joint at an equal distance apart (9 and 3 o'clock positions) around the joint. 3. Use six (6) wedges per joint for pipes larger than 24-Inches in diameter only if building services are directly connected to the main. Wedges must be installed side by side in pairs 120 degrees apart at the 12, 4, and 8 o'clock positions around the joint.

D. Assemble restrained joint pipe in accordance with manufacturer's instructions.

18.10 DEPTH OF PIPE COVER

A. Unless otherwise shown on the Plans, all water mains and services must be installed so a minimum pipe cover is achieved as shown in Table D.

Table D – Minimum Depths of Cover for Water Mains

| Size of Pipe | Depth of Cover |
|---|---|
| 3/4 to 3-inches | 5-ft 6-inches+ 3-inches |
| 4-inch | 5-ft 6-inches + 3-inches |
| 6-inch | 5-ft 6-inches + 3-inches |
| 8-inch | 5-ft 3-inches + 3-inches |
| 10-inch | 5-ft + 2-inches |
| 12-inch | 5-ft + 2-inches |

18.11 CONSTRUCTION PROCEDURES

A. Bedding: All water mains shall be laid on a six-inch (6") layer of CA-11 limestone.

As established by Contractor, or where necessary because of soil conditions, concrete cradles or concrete encasement shall be built. The pad section of a cradle or encasement shall be built at least twelve (12) hours before pipe laying. Enough No. 9 annealed iron pipes shall be embedded in the pad and subsequently tied around the pipe to prevent the pipe from moving offline and/or grade.

B. Installation of Pipe: Before lowering the pipe into the trench and while suspended, each pipe shall be inspected by the Contractor for defects. Defective, damaged, or unsound pipe shall be immediately removed from the site. The interior of each pipe shall be inspected for cleanness and cleared of all dirt and foreign matter before being lowered into the trench.

Unless otherwise directed, pipe shall be laid with bell ends facing in the direction of laying. After a length of pipe is placed in the trench, the spigot shall be centered in the bell of the preceding pipe, the pipe shoved into position and brought to true alignment and there secured with sand tamped under and on each side of the pipe, excepting at bell holes. No earth or other foreign matter shall be allowed to enter the joint space.

The bells, spigots and rubber gaskets shall then be thoroughly washed in soapy water so that no particles of sand of grit can damage the gasket. Slip-on joints shall be constructed in strict accordance with the manufacturer's recommendations.

C. Backfilling:

Backfill of auxiliary valves and line valves shall be carefully tamped to insure proper alignment. Contractor shall properly align and set to grade all valve boxes after completion of curb and gutter construction.

Pipe Zone: CA-16 crushed limestone granular backfill shall be carefully placed and thoroughly tamped and compacted around the pipe with hand tools up to the spring line of the pipe in accordance with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil".

Granular Trench Backfill: All trenches and the excavation around fire hydrants, valves and other appurtenances which occur within the limits of existing or proposed pavements, sidewalks and curb and gutters, or where the edge of the trench shall be within two feet (2') of said improvements shall be backfilled with compacted granular backfill in accordance with Section 31 23 23 "Acceptance of Backfill, Topsoil, & CU Structural Soil".

Guarantee: The contractor shall guarantee all work for a period of one year after acceptance by the CHA. Any trenches improperly backfilled or where settlement occurs shall be reopened and properly compacted. The cost of any corrections and/or repair of any damages to other facilities shall be the responsibility of the Contractor.

## 18.12 TESTING, DISINFECTION, AND FLUSHING OF DOMESTIC WATER LINES

A. Procedures shall be submitted to the local authorities for approval prior to testing. Tests shall be conducted using the more stringent procedures as approved by local authorities and as mandated by the City of Chicago Department of Water Management, Design Guidelines for Water Main Installations, dated April 2009.

B. Testing of the newly laid piping or any valved section of piping shall be accomplished after the lines are laid, the joints and accessories installed, and the trench partially backfilled, leaving the joint exposed for examination. The piping shall be subjected for a minimum of two hours to a pressure of one and one-half times the working pressure, but in no case less than l00 psi (689 kPa). Examine all exposed pipe, joints, fittings, and accessories during the test period. Replace or repair defective portions of the system and repeat tests until results are satisfactory. Allowable leakage shall be as specified in AWWA C-600, Table 3.

## 18.13 WATER SERVICE TAPPING

A. Connection to the City water main shall be made by the City of Chicago Water Department. Contractor shall coordinate final connection with the city. The contractor shall reimburse the City for their costs at the rate per tap.

**END OF SECTION**

**SECTION 33 30 00**

**SEWERAGE AND DRAINAGE**

## PART 19 - GENERAL

19.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

19.02 SUMMARY

A. Section Includes:

1. Sewerage and Drainage system as indicated and specified
2. Pipes and Fittings
3. Non-pressure transition couplings
4. Encasement piping
5. Manholes
6. Catch basins
7. Inlets
8. Subsurface Detention Systems
9. Frames and Grates
10. Cleanouts
11. Area Drains
12. Trench Drains
13. Concrete
14. Protective Coatings
15. Restrictors
16. Backflow Preventors

B. Related Requirements

1. Section 31 22 14 “Earthwork”.
2. Section 31 23 33 “Excavating Backfilling Compacting for Utilities”.
3. Section 31 13 13 “Concrete Paving”.
4. Section 33 10 00 “Water Service”.

19.03 SUBMITTALS

A. Product Data: Provide product data for each product specified.

B. Manufacturers literature, installation instructions, dimensions, materials, standards, certifications and guarantees.

C. Shop drawings for precast concrete manholes and other structures. Include frames, covers, and grates.

D. Inspection and test reports specified in the "Field Quality Control" Article.

19.04 QUALITY ASSURANCE

A. Perform Work in accordance with Illinois Department of Transportation (IDOT) "Standard Specifications for Road and Bridge Construction".

1. Measurement and payment provisions and safety program submittals included in IDOT Standard Specifications do not apply to this Section.

B. Environmental Agency Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems.

C. Utility Compliance: Comply with regulations pertaining to sanitary sewerage and storm drainage systems. Include standards of water and other utilities where appropriate.

D. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of system components.

19.05 PERFORMANCE REQUIREMENTS

A. Gravity Flow, Non-pressure Piping Pressure Ratings: At least equal to system test pressure.

19.06 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle precast concrete manholes and other structures according to manufacturer's rigging instructions.

19.07 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the CHA or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

1. Notify Architect not less than 48 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without receiving Architect's written permission.

19.08 SEQUENCING AND SCHEDULING

A. Coordinate with interior building drainage systems.

B. Coordinate with other utility work.

## PART 20 - PRODUCTS

20.01 MATERIALS

A. Pipes and Fittings

1. Push-on-Joint, Ductile-Iron Pipe:

   a. AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   b. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   c. Gaskets: AWWA C111, rubber.

2. Extra strength vitrified clay pipe:

   a. Vitrified clay pipe and fittings must be extra strength clay bell and spigot pipe conforming to the requirements of ASTM C700.

3. Reinforced Concrete Pipe:
   a. Conform to ASTM C76 and AWWA C302.
   b. Joints conforming to ASTM C361 and AWWA C302.

B. Non-pressure Transition Couplings

1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on eachend.
2. Sleeve Materials:
   a. For Concrete Pipes: ASTM C 443 rubber.
   b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   c. For Dissimilar Pipes: ASTM D 5926, PVC, or other material compatible with pipe materials being joined.

3. Shielded, Flexible Couplings:

   a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

4. Ring-Type, Flexible Couplings:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

      1) Fernco Inc. “Fernco Couplings”.
      2) Mission Rubber Company; a division of MCP Industries, Inc. “Mission Couplings”.
      3) Naylor Inc. “Band Seal Couplings”.

C. Polyethylene Encasement for Ductile Iron Pipe

1. Standard: AWWA C105.
2. Material: High-density, cross-laminated polyethylene tubing of 4-mil minimum thickness.
3. Form: Tube.
4. Color: Black.

D. Precast Concrete Manholes

1. ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints.

    a. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent floatation.
    b. Base Section: 6 inch (150 mm) minimum thickness for floor slab and 4 inch (100 mm) minimum thickness for walls and base riser section and having a separate base slab or base section with integral floor.
    c. Riser Sections: 4-inch (100 mm) minimum thickness, 48-inch (1220 mm) diameter, and lengths to provide depth indicated.
    d. Top Section: Eccentric cone type unless concentric cone or flat slab top type is indicated. Top of cone of size that matches grade rings.
    e. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
    f. Grade Rings: Include 2 or 3 reinforced concrete rings, of 6-to-9-inch (152 to 229 mm) total thickness, that match a 24-inch (610 mm) diameter frame and cover.
    g. Steps: ASTM C 478 (ASTM C 478M) individual steps or ladder. Omit steps for manholes less than 60 inches (1500 mm) deep.
    h. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.

E. Catch Basin/Inlets

1. ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints.

    a. Base Section: 6 inch (150 mm) minimum thickness for floor slab and 4 inch (100 mm) minimum thickness for walls and base riser section and having a separate base slab or base section with integral floor.
    b. Riser Sections: 4-inch (100 mm) minimum thickness; 48-inch (1220 mm) diameter, and lengths to provide depth indicated.
    c. Top Section: Eccentric cone type unless concentric cone or flat slab top type is indicated. Top of cone of size that matches grade rings.
    d. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
    e. Grade Rings: Include 2 or 3 reinforced concrete rings, of 6-to-9-inch (152 to 229 mm) total thickness, that match a 24-inch (610 mm) diameter frame and grate.
    f. Steps: ASTM C 478 (ASTM C 478M) individual steps or ladder. Omit steps for catch basins less than 60 inches (1500 mm) deep.

F. Frames and Grates

1. Manhole Frames and Covers: ASTM A-48, Class 35B, cast gray iron and per current city code. Include indented top design with lettering cast into cover:

    a. Storm Drainage Piping Systems: Raised flush letters per current city code

G. Concrete

1. General: Cast in place concrete per ACI 318, ACI 350R, and the following:

   a. Cement: ASTM C 150, Type II.
   b. Fine Aggregate: ASTM C 33, sand.
   c. Coarse Aggregate: ASTM C 33, crushed gravel.
   d. Water: Potable.

2. Structures: Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water cement ratio.

   a. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   b. Reinforcement Bars: ASTM A 615, Grade 60 (ASTM A 615M, Grade 400), deformed steel.

H. Protective Coatings

1. General: Include factory or field applied protective coatings to structures and appurtenances according to the following:
2. Coating: 1 or 2 coat, coal tar epoxy, 15 mil (0.381 mm) minimum thickness, except where otherwise indicated.
3. Manholes: On exterior surfaces.
4. Catch Basins: On exterior surfaces.

**PART 21 - EXECUTION**

21.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 23 33 “Excavating Backfilling Compacting for Utilities.”

B. All excavation and backfilling must be conducted in accordance with Section 31 23 18.13 “Subtitle D Waste Disposal” and 31 23 23 “Acceptance of Backfill, Topsoil, & CU Structural Soil.”

21.02 IDENTIFICATION

A. Install green warning tapes directly over piping and at outside edges of underground structures.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

21.03 GENERAL INSTALLATION

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground sewerage and drainage systems piping. Location and

arrangement of piping layout consider many design considerations. Install piping as indicated, to extent practical.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Install gravity flow systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

D. Extend piping and connect to building's drains, of sizes and in locations indicated. Terminate piping as indicated.

E. Install piping pitched down in direction of flow.

21.04 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to the following:

1. Push-on joint bell and plain spigot, ductile-iron pipe per AWWA C600.
2. Install RCP piping in accordance with ASTM C1479.

21.05 MANHOLE INSTALLATION

A. General: Install manholes, complete with accessories, as indicated.

B. Set tops of frames and covers flush with finished surface where manholes occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere, except where otherwise indicated.

C. Place precast concrete manhole sections as indicated and install according to ASTM C 891.

1. Provide rubber joint gasket complying with ASTM C 443 (ASTM C 443M), at joints of sections.
2. Apply bituminous mastic coating at joints of sections.

21.06 CATCH BASIN/INLET INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

21.07 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so finished work conforms as nearly as practical to requirements specified for new work.

B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150 mm) overlap, with not less than 6 inches (150 mm) of 3000 psi (20.7 MPa), 28-day, compressive strength concrete.

C. Make branch connections from side into existing piping, sizes 4 to 20 inches (100 to 500 mm) by removing a section of existing pipe and installing a wye fitting into existing piping. Encase entire wye with not less than 6 inches (150 mm) of 3000 psi (20.7 MPa), 28-day, compressive strength concrete.

1. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa), unless otherwise indicated.
2. Use epoxy bonding compound as an interface between new and existing concrete and piping materials.

D. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

21.08 FIELD QUAILITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and whenever work stops.
3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris

B. Testing of the newly laid piping or any valved section of piping shall be accomplished after the lines are laid, the joints and accessories installed, and the trench partially backfilled, leaving the joint exposed for examination. The piping shall be subjected for a minimum of two hours to a pressure of one and one-half times the working pressure, but in no case less than l00 psi (689 kPa). Examine all exposed pipe, joints, fittings, and accessories during the test period. Replace or repair defective portions of the system and repeat tests until results are satisfactory. Allowable leakage shall be as specified in AWWA C-600, Table 3.

C. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of the Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visual between structures.
b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

D. Test new piping systems and parts of existing systems that have been altered, extended, or repaired for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests, and their inspections by authorities having jurisdiction, with at least 24 hours' advance notice.
4. Submit separate reports for each test:

a. Storm Drainage: Perform hydrostatic test.

1) Allowable leakage is a maximum of 200 gallons per inch nominal pipe size, for every mile of pipe, during a 24-hour period.
2) Close openings in system and fill with water.
3) Purge air and refill with water.
4) Disconnect water supply.
5) Test and inspect joints for leaks.
6) Storm Drainage: Perform hydrostatic test. Close openings in system and fill with water to not less than 10-foot (3 m) head of water. Disconnect water supply. Water level must not drop for 15 minutes. Inspect joints for leaks.

21.09 CLEANING

1. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

**END OF SECTION**