JUDGE WENDELL GREEN APARTMENTS RENOVATION

PROJECT MANUAL SPECIFICATIONS

ISSUED FOR BID CONSTRUCTION DOCUMENTS

OCTOBER 29, 2021

The following listed documents comprise the project manual for the project listed above. Where numerical sequence of sections is interrupted, such interruptions are intentional. The complete Project Manual for this project consists of this entire Volume, which must not be separated for any reason.

This Project Manual shall be reviewed in combination with following issued drawings sets:

BID DOCUMENTS 10/29/2021

The Architect and Owner disclaim any responsibility for any assumptions made by a contractor or subcontractor who does not receive a complete Project Manual, including all sections listed in the Table of Contents.

All Division 01 Sections are a part of and apply to each and every Section of the Project Manual Specifications.

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END OF SECTION

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. Work under separate contracts.
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: Judge Wendell Green Apartments , P1805.

1. Project Location: 4030 S Lake Park Ave. Chicago, IL 60653 .

B. Owner: Chicago House Authority (CHA).

1. The CHA's Designated Representative: Don Oshita, DOshita@thecha.org.

C. Architect: Canopy / architecture + design, LLC, 180 W Washington St Suite 200, Chicago, IL 60602.

1. Architect's Representative: , Jaime Torres, jtorres@canopy-chicago.com. (312) 763-8005

D. Architect's Consultants: Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. MEP Engineer:

a. dbHMS
303 Erie Street #510
Chicago, IL 60654
Phone: (773) 915-0557

2. Civil Engineer:

a. David Mason + Associates
333 S. Desplaines Street, Suite 200
Chicago, IL 60661
Phone: (312) 884-5100

3. Structural Engineer:

a. David Mason + Associates
333 S. Desplaines Street, Suite 200
Chicago, IL 60661
Phone: (312) 884-5100

1.4 WORK COVERED BY CONTRACT DOCUMENTS

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

1. Selective demolition, exterior, and interior renovation to an existing 13-story plus penthouse senior public housing apartment building in Chicago. Significant scope includes a new entry canopy and vestibule. Interior scope includes reconfiguring and updating amenity spaces, replacement of finishes, and improvements to accessibility and life safety systems. Other exterior scope includes improved rooftop terrace, roof replacement, and repairs and replacement to masonry and windows.

B. Type of Contract:

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

1.5 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

B. Concurrent Work: The CHA has awarded or will award separate contract(s) for the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.

1. Hazardous materials remediation.

1.6 CHA-FURNISHED PRODUCTS

A. CHA-Furnished Products:

1. Refer to Drawings.

1.7 ACCESS TO SITE

A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by the CHA's right to perform work or to retain other contractors on portions of Project.

B. 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.

C. 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 drivewaysparking garage, and 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.

D. 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.

E. 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.

1.8 COORDINATION WITH OCCUPANTS

A. Partial CHA Occupancy: The CHA will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with the CHA during construction operations to minimize conflicts and facilitate CHA usage. Perform the Work so as not to interfere with CHA's 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 authorities having jurisdiction.
2. Provide not less than 72 hours' notice to CHA of activities that will affect CHA's operations.

1.9 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.

1.10 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 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. 3 - Masonry Repair, Tuckpointing:

1. Description: <Insert unit-price item description> according to Section <Insert Section number> "<Insert Section title>."
2. Unit of Measurement: <Insert unit of measurement>.
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 are unacceptable.

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: _____

TO: ARCHITECT: _____
CC: CHA'S DESIGNATED
REPRESENTATIVE: _____
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 01 21 00 "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 01 22 00 "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.
   g.

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.

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.

C. Fan Coil Installation Procedures: Coordinate scheduling and timing of fan coil scope of work procedures with other activities to avoid conflicts and to ensure progress of the Work per the schedule listed below:

FAN-COIL UNIT INSTALLATION SCHEDULE (per unit)			
DAY	**HOURS**	**TRADE**	**WORK ITEM**
Day 1	2	Labor	Furniture Moving (CHA workers)
	2	Labor	Demolition (Partition)
	2	Labor	Demolition (Coring)
Day 2	2	Electrician	Wiring installation
	2	HVAC	Riser installation
Day 3	2	HVAC	Fan coil installation
	3	Carpenter	Metal studs, drywall & taping
Day 4	2	HVAC	Final piping connections
	3	Painter	Taping, priming & finish painting
Day 5	4	Labor	Cleaning & furniture reinstallation
Day 6	**UNFORSEEN CONDITIONS**		

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. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
2. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
3. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.

c. Fire-rated enclosures around ductwork.

4. Electrical Work

5. 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 e-Builder.
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, 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 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 02 41 19 "Selective Demolition" for photographic documentation before selective demolition 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. Take 20 photographs to show existing conditions adjacent to property before starting the Work.
2. Take 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
3. 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 schedulerequirements.
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 materialsubmittals.
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.

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.

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 35 62

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Erosion and Sedimentation Control Program for the Project.

1.2 SUBMITTALS

A. Erosion and Sediment Control Plan

1. Submit erosion and sediment control drawings specific to the site within ten (10) days of Notice To Proceed (NTP). Show locations, types and details of erosion and sediment control features and construction.
2. Show the schedule of implementation coordinated with the construction schedule.
3. Include a narrative describing the program and maintenance.

B. Product Data

1. Silt Fence Geotextile Filter Fabric
2. Filter Baskets

C. Documentation Log

1. Provide weekly inspection logs of inspection and maintenance of all erosion control procedures.

    a. Include additional inspections for rainfalls over ½".

2. Provide photographs during construction illustrating implementation of erosion control measures and on-going repairs/maintenance to these measures. At minimum photographs should be documented for:

    a. Before Construction
    b. During Construction
    c. After Construction

1.3 QUALITY ASSURANCE

A. Requirements: Create and implement an Erosion and Sedimentation Control plan, specific to the site, which conforms to the erosion and sedimentation requirements of the 2003 United States Environmental Protection Agency (EPA) Construction General Permit, OR local erosion and sedimentation control standards and codes, whichever is more stringent. The Construction

General Permit outlines the provisions necessary to comply with Phase I and Phase II Of the National Pollution Discharge Elimination (NPDES) program.

B. Objectives:

1. Prevent loss of soil during construction by storm water runoff and/or wind erosion, including protecting stock piles for reuse.
2. Prevent sedimentation of storm sewer or receiving streams.
3. Prevent polluting the air with dust and particulate matter.

PART 2 - PRODUCTS

2.1 SILT FENCE:

A. Geotextile Filter Fabric: A nonwoven fabric consisting of previous sheets of propylene, nylon, polyester, or ethylene yarn. Certify material by manufacturer to meet the following requirements. Pre-assembled silt fencing may be substituted if it meets the requirements below.

Property	Test Method	Requirements
Minimum Tensile Strength	ASTM D4632	90 lb
Maximum Elongation at 45 lb	ASTM D4632	50% Max
Apparent Opening Size	ASTM D4751	AOS<60 mm
Minimum Permittivity	ASTM D4491	1x10-2 SEC -1
Ultraviolet Exposure Strength Retention	ASTM D4355	70% @ 500h

B. Posts: Wood or steel and a minimum 5 ft long. Wood posts shall be at least 4 in. dia. Or nominal 2 x 2 in. Steel posts shall be round or “U”, “T”, or “C” shaped with a minimum weight of 1.33 lb/ft and projections for fastening wire to fence. Wire Staples: 9 gage and minimum 1 in. long.

2.2 INLET FILTER

A. FILTER BASKETS

1. Manufacturer and Products: See Drawings.

2.3 CONSTRUCTION ENTRANCE

A. Aggregate size: CA-1 or CA-4

B. Geotextile fabric: shall meet the requirements of specification 592 Geotextile table 1 or 2, class I, II or IV of the Illinois Urban Manual.

2.4 TEMPORARY SEEDING PLANTS

A. Shall be selected from the following:

PART 3 - EXECUTION

3.1 GENERAL

A. Do not start operations until the erosion and sediment control plan has been submitted and features and in place.

B. Schedule the Work in start to finish phases to minimize exposing the site to erosion.

C. Install erosion and sediment control features before site disturbance begins and immediately after new inlets are installed.

D. Do not allow storm water to flow into excavations and disturbed areas.

E. Do not discharge water into sanitary sewers, watercourses or offsite.

F. Do not discharge water-containing sediment in accordance with "Quality Assurance" requirements and as presented in the erosion and sediment control plan submittal or a maximum retained as 30 milligrams of sediment per liter of water. Conduct continuous monitoring of sediment.

G. Maintain sediment control features. Inspect weekly and after every rain. Repair damaged bales, end runs and undercutting beneath bales. Repair breaks in diversion dams and damage down streams of the break. Replace damaged and deteriorated filter fabric and fences. Remove sediment which deposits fill 1/3 of the fabric surface area.

H. Do not allow sediment to flow into vegetated areas.

I. Retain all sediment on the site. Provide temporary stone roadways at exits from the site to ensure mud run-off of tires before exiting.

J. Utilize the sizes of equipment appropriate to the task to minimize exhaust, noise and vibration.

K. Mist or provide other means to keep dust from being scattered to the air.

L. All sediment that gets onto public right-of-way must be removed immediately.

M. During dewatering operations, water will be pumped into sediment basins or silt traps. Dewatering directly to field tiles or storm sewer is prohibited.

N. Stock pile must be kept covered and watered for dust control.

3.2 INSTALLATION/APPLICATION/ERECTION

A. General: Control surface water runoff on-site and provide temporary soil stabilization measures as required to prevent erosion of soil by action of water. Protect storm sewers adjacent to work site from sedimentation by installation of erosion and sediment control measures. Provide, as a first step in construction operations, barriers, and other measures intended to deter erosion and transport of sediment associated with construction activities before construction starts or as it progresses.

B. Silt Fences: Space posts 6 ft maximum for non-reinforced or 10 ft maximum for reinforced and securely install with at least 2 feet of post in the ground. Excavate trench approximately 4 in. wide and 4 in. deep along line of posts and upslope side of posts using wire staples, tie wires, or hog rings. Extend wire and fence into trench a minimum of 4 in. Attach geo-textile filter fabric directly to posts and wire reinforcement fence as required by wire, staples, or other means accepted by the ANL CFR. Install filter fabric in a manner such that fabric height above grade is 2 to 3 ft. Do not staple fabric to trees. Do not use fabric with defects or other damage. For manholes, the filter fabric can be placed around the lid and secured by the lid weight.

C. Construction Entrance: Construct with minimum dimensions of 14’ wide, 70’ length and 6” thickness of CA-1 or CA-4. Filter fabric shall be used under the aggregate to minimize the migration of stone into the underlying soil by heavy vehicle loads. See plans for location.

D. Temporary Seeding: Remove large rocks or other debris that may interfere with seedbed preparation or seeding operations. Prepare seedbed of 3 to 4 inches loose soil. If rainfall has caused the surface to become sealed or crusted, loosen, by suitable method, it just prior to seeding. Where pH is below 5.5 and seeding will not take place within 30 days, apply one and one half to two tons per acre of finely ground agricultural limestone. Seeding shall be evenly applied with a cyclone seeder, drill, culti-packer seeder or hydroseeder. Small grains shall be planted no more than one inch deep. Grasses shall be planted no more than one half inch deep.

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 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 inspection.

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.

1.7 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.

1.8 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.

1.9 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 size indicated.
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.

L. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop 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.

1.10 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. The CHA will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Payment for these services will be made from testing and inspection allowances, as authorized by Change Orders.
3. 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 01 33 00 "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.

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 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.

1.4 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 50 4 and ICC/ANSI A117.1.

1.5 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. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide galvanized-steel bases for supporting posts.

B. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.

C. 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.

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

E. 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 TEMPORARY ENCLOSURES

A. Provide temporary weathertight closures for exterior openings to provide acceptable interior conditions for vestibule area to allow for temporary heating and maintenance of ambient temperatures, to allow for public access and to prevent entry of unauthorized persons.

1. Provide ADA-compliant access doors with automatic openers.
2. Provide locking hardware keyed to building's existing key-FOB access system.

2.4 EQUIPMENT

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

B. HVAC Equipment: Unless the CHA authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: If the CHA authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 01 77 00 "Closeout Procedures."

C. 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 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. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. 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.

E. 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.

F. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

1. Install electric power service overhead unless otherwise indicated.
2. Connect temporary service to CHA's existing power source, if available and as directed by 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.
8. Productivity Software:

a. Microsoft Office Professional, including Word, Excel, and Outlook.

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: Provide temporary parking areas for construction personnel.

D. 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.

E. 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 Soils”, as applicable.

F. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

G. Temporary Elevator Use: Contractor will will have temporary use of existing elevators, concurrent with residents.

H. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

I. Temporary Use of Permanent Stairs: Use of existing stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

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. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.

E. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

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

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

H. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.

1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
2. Paint and maintain appearance of walkway for duration of the Work.

I. 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.

J. 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.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

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. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. 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 02 83 19.13.

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. 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.

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. 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 31 22 14 "Earthwork" and Section 31 23 23 "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 32 93 00 "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:

    a. Primary operational systems and equipment.
    b. Fire separation assemblies.
    c. Air or smoke barriers.
    d. Fire-suppression systems.
    e. Plumbing piping systems.
    f. Mechanical systems piping and ducts.
    g. Control systems.
    h. Communication systems.

i. Fire-detection and -alarm systems.
j. Conveying systems.
k. Electrical wiring systems.
l. Operating systems of special construction.

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. Sprayed fire-resistive material.
d. Equipment supports.
e. Piping, ductwork, vessels, and equipment.
f. 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. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. 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 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.

B. General: Engage a professional engineer to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

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3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

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.

3.6 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. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.

D. 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.

E. 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."

F. 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.

G. 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. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
5. Proceed with patching after construction operations requiring cutting are complete.

H. 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.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.7 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.

3.8 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 "Quality Requirements."

3.9 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.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to the CHA that may be uncovered during demolition remain the property of the CHA.

1. Carefully salvage in a manner to prevent damage and promptly return to the CHA.

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.

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 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. Asphalt paving.
    b. Concrete.
    c. Concrete reinforcing steel.
    d. Brick.
    e. Concrete masonry units.

ll. Ballasts.
mm. Electrical devices.
nn. Switchgear and panelboards.
oo. Transformers.

2. Construction Waste:

a. Masonry and CMU.
b. Metals.
c. Roofing.
d. Insulation.
e. Electrical conduit.
f. 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.

g. 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. 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. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum 1-1/2-inch (38-mm) size.
2. Crush concrete and screen to comply with requirements in Section 31 22 14 "Earthwork" for use as satisfactory soil for fill or subbase.

B. 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.

C. Conduit: Reduce conduit to straight lengths and store by material and size.

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. 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 or settlement surveys, property surveys, 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. Make final changeover of permanent locks and deliver keys to CHA. Advise CHA's personnel of changeover in security provisions.
2. Complete startup and testing of systems and equipment.
3. Perform preventive maintenance on equipment used prior to Substantial Completion.
4. 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."
5. Advise CHA of changeover in utility services.

6. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
7. 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: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by the CHA during construction period by separate agreement with Contractor.

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. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. 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.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.

j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
o. 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.

p. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
q. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 01 50 00 "Temporary Facilities and Controls." Prepare written report.

D. 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.

4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

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

Marlon Hollis
2020-05-08 19:31:00
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yes uld operation and maintenance manuals submitted in as electronic files or paper copies, or both? file for minimum readable ts based on file names. Name

A. Manuals, Electronic Files: Submit manuals in the form of a multipl PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufactu scanning of paper documents is required, configure scanned file size.
2. File Names and Bookmarks: Bookmark individual document 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 - Not Used

PART 3 - EXECUTION - Not Used

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 the CHA's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. Demonstration and training video recordings.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

B. Qualification Data: For facilitator, instructor and videographer.

C. Attendance Record: For each training module, submit list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven 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 Contractor.
e. Date of video recording.

2. 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.
3. At completion of training, submit complete training manual(s) for the CHA's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 01 78 23 "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 01 40 00 "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. Preinstruction 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 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 the CHA's operations. Adjust schedule as required to minimize disrupting CHA's operations and to ensure availability of CHA'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 INSTRUCTION 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 01 78 23 "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 the CHA's Designated Representative for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct the CHA's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. The CHA's Designated Representative 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 the CHA, through Architect and the CHA's Designated Representative, with at least seven 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 a demonstration performance-based test.

F. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.10 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. 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 16 megapixels and capable of recording in full HD mode with vibration reduction technology.

1. Submit video recordings on CD-ROM or thumb drive and by uploading to web-based Project software site.
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 audio narration by microphone while, or dubbing audio narration off-site after, video recording is recorded. 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 021910
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 SCOPE OF WORK

WORK AREA	LOCATION	MOLD REMEDIATION SCOPE OF WORK	ESTIMATED QUANTITY	UNIT
FLOOR #	ROOM ###	REMOVE MOLD IMPACTED XXXX LOCATED AT THE XXXX	##	SF
FLOOR #	ROOM ###	REMOVE MOLD IMPACTED XXXX LOCATED AT THE XXXX	##	SF
FLOOR #	ROOM ###	REMOVE MOLD IMPACTED XXXX LOCATED AT THE XXXX	##	SF

FLOOR #	ROOM ###	REMOVE MOLD IMPACTED XXXX LOCATED AT THE XXXX	##	SF
FLOOR #	ROOM ###	REMOVE MOLD IMPACTED XXXX LOCATED AT THE XXXX	##	SF

1.5 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.

1.6 LAWS, REGULATIONS AND STANDARDS

A. The following laws, regulations and standards are incorporated by reference:
   1. 29 CFR 1910.134 - OSHA Respiratory Protection Standard
   2. 29 CFR 1910.1200 - OSHA Hazard Communication Standard

1.7 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.

1.8 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).

1.9 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.

1.10 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
   a. Seal off all doorways and corridors that will not be used for passage during work.
   b. 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.

1.11 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.

1.12 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.

1.13 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.

1.14 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 024119
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. Work Results

B. Principal Products

C. 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.

D. 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.

E. 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: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by CHA before start of the Work.
   2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and the CHA's Designated Representative. Hazardous materials will be removed by CHA under a separate contract.

E. 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.

F. Storage or sale of removed items or materials on-site is not permitted.

G. 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.

H. Conduct operations with a minimum interference to public or private thoroughfares.

I. Maintain protected egress and access at all times.

J. Do not obstruct public roadways or sidewalks without proper permits.

K. 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.
      a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
      b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
      c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
      d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
      e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to CHA.
      f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
      g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

B. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

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 50 00 "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. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

D. 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.

E. 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 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 on Record (AOR) 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 AOR.
   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 responsible 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 150^0F.
    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 AOR. All punch list items shall be completed within five working days of walk through.

END OF SECTION 02 82 14

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 of Record (AOR) 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 areneeded.

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

All equipment shall at least conform to minimum industry standards:

A. 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.

B. 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, AOR, and CHA's Designated Representative. All punch list items shall be completed within five working days of walk through.

END OF SECTION 02 82 15

SECTION 028613
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:
      b. Hazardous Substances, Title 49, Part 171 and 172 of the Code of Federal Regulations.
      c. Hazardous Material Regulations, General Awareness and Training Requirements for Handlers, Loaders and Drivers, Title 49, Parts 171-180 of the Code of Federal Regulations.
      d. Hazardous Material Regulations, Editorial and Technical Revisions, Title 49, Parts 171-180 of the Code of Federal Regulations.
      e. EPA: U. S. Environmental Protection Agency (EPA), including but not limited to the following:
      f. Management of Hazardous Wastes Resource Conservation and Recovery Act (RCRA), Title 40, Parts 260-299 of the Code of Federal Regulations.
      g. Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, and Use Prohibitions, Title 40, Parts 761, of the Code of Federal Regulations.
      h. Protection of Stratospheric Ozone, Title 40, Part 82 of the Code of Federal Regulations.

1) Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Title 42, Section 103.
2) Universal Waste Rule, Title 40, Part 273 of the Code of Federal Regulations.

i. LABOR: Occupational Safety and Health Administration, including but not limited to:
j. Occupational Safety and Health Guidelines, Respiratory Protection, Title 29, Part 1910.134.
k. Occupational Safety and Health Guidelines, Occupational Safety and Health Standards, Lead, Title 29, Part 1910.1025.
l. Occupational Safety and Health Guidelines, Occupational Safety and Health Standards, Hazard Communication, Title 29, Part 1910.1200.
1) 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 isless:
   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:
   d. A copy of state and local special waste and/or hazardous waste hauler licenses for each transporter must be provided in the Plan.
   e. U.S. EPA Identification Number of waste hauler.
   f. Current list of all transporting vehicles to be used including:
   g. Vehicles make, model and year.
   h. Serial number for each vehicle.
   i. Vehicle license number.
   j. Number of axels.
   k. Weight capacity of vehicle.
   l. A list of all licensed qualified truck drivers. Drivers should be able to provide their drivers license upon request.
   m. 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:
      1) Contact person and telephone number.
      2) Copy of state license and permit.
      3) 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 harmed by emergency spills.
6. Lead-containing Paint Management:
   a. A description of the work procedures that will be utilized to minimize the 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:
      d. Hydraulic-lift elevators
      e. Hydraulic trash compactors
      f. 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 placed in 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 CIRCUMSTANCES 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 033000 - CAST-IN-PLACE CONCRETE

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. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:
1. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
2. Section 321313 "Concrete Paving" for concrete pavement and walks.
3. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete Subcontractor.
e. Special concrete finish Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.
c. Semirigid joint fillers.
d. Vapor-retarder installation.
e. Anchor rod and anchorage device installation tolerances.
f. Cold and hot weather concreting procedures.
g. Concrete finishes and finishing.
h. Curing procedures.
i. Forms and form-removal limitations.
j. Shoring and reshoring procedures.
k. Methods for achieving specified floor and slab flatness and levelness.
l. Floor and slab flatness and levelness measurements.
m. Concrete repair procedures.
n. Concrete protection.
o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
p. Protection of field cured field test cylinders.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement
7. Aggregates.
8. Admixtures:

    a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.

9. Color pigments.
10. Vapor retarders.
11. Floor and slab treatments.
12. Liquid floor treatments.
13. Curing materials.

    a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.

14. Joint fillers.
15. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.
9. Synthetic micro-fiber content.
10. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
11. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
12. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
13. Intended placement method.
14. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Samples: For vapor retarder.

D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.

2. Admixtures.
3. Curing compounds.
4. Floor and slab treatments.
5. Bonding agents.
6. Adhesives.
7. Vapor retarders.
8. Semirigid joint filler.
9. Joint-filler strips.
10. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates.
8. Admixtures:

a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301 (ACI 301M).

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F (1.7 deg C), other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M), and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F (35 deg C).
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents: ACI 301.

2.2 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. 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.

D. 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.

2.3 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, Grade 60.
   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.

2.4 CONCRETE MATERIALS

A. Source Limitations:

   1. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
   2. Obtain aggregate from single source.
   3. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

   1. Portland Cement: ASTM C150/C150M, Type I/II, gray.
   2. Fly Ash: ASTM C618, Class C or F.
   3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
   4. Blended Hydraulic Cement: ASTM C595/C595M, Type IL, portland-limestone cement.
   5. Silica Fume: ASTM C1240 amorphous silica.
   6. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: Type GU, general use.

C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

   1. Alkali-Silica Reaction: Comply with one of the following:

      a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.

b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).

2. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.

8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

9. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).
   a. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRC C48 at a hydraulic pressure of 200 psi for 14 days.

F. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments, color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
   1. Color: As selected by Architect from manufacturer's full range.

G. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.5 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

B. Sheet Vapor Retarder, Class C: ASTM E1745, Class C; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

2.6 FLOOR AND SLAB TREATMENTS

A. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
   1. Color: As selected by Architect from manufacturer's full range.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

   1. Color:

      a. Ambient Temperature Below 50 deg F (10 deg C): Black.
      b. Ambient Temperature between 50 deg F (10 deg C) and 85 deg F (29 deg C): Any color.
      c. Ambient Temperature Above 85 deg F (29 deg C): White.

D. Curing Paper: Eight-feet- wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

E. Water: Potable or complying with ASTM C1602/C1602M.

F. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Floor Slab Protective Covering: Eight-feet- wide cellulose fabric.

2.9 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4,000 psi at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 4,000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.10 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use high-range water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
5. Use permeability-reducing admixture in concrete mixtures where indicated.

D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.11 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, beams and foundation walls.

1. Exposure Class: ACI 318 (ACI 318M) S0.
2. Minimum Compressive Strength: 4,000 psi at 28 days.
3. Maximum w/cm: 0.45.
4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Slump Flow Limit: 22 inches, plus or minus 1.5 inches.

6. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
7. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

B. Class B: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 (ACI 318M) S0.
2. Minimum Compressive Strength: 4,000 psi at 28 days.
3. Maximum w/cm: 0.45.
4. Minimum Cementitious Materials Content: 540 lb/cu. yd..
5. Slump Limit: 4 inches, plus or minus 1 inch.
6. Slump Flow Limit: 22 inches, plus or minus 1.5 inches.
7. Air Content:

    a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

8. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and ASTM C1116/C1116M, and furnish batch ticket information.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure facilities for storage, initial curing, and field curing of test samples, including continuous electrical power.
4. Security and protection for samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.4 JOINTS

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M), but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

3.6 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

    a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    b. Remove projections larger than 1/4 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117 (ACI 117M) Class B.
    e. Locations: Apply to concrete surfaces exposed to public view.

B. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.7 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. 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.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 12 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4,000 psi at 28 days.
4. 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.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.

    a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Cast anchor-bolt insert into bases.
    c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.8 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 (ACI 301M) and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M) for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply in accordance with manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Curing Formed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:

    a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
    e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

        1) Recoat areas subject to heavy rainfall within three hours after initial application.
        2) Maintain continuity of coating and repair damage during curing period.

D. Curing Unformed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:

    a. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

        1) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

            a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
            b) Cure for not less than seven days.

        2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

            a) Water.

b) Continuous water-fog spray.

b. Floors to Receive Curing and Sealing Compound:

1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.9 TOLERANCES

A. Conform to ACI 117 (ACI 117M).

3.10 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month.
2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

a. Limit cut depth to 3/4 inch.
b. Make edges of cuts perpendicular to concrete surface.

c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
d. Fill and compact with patching mortar before bonding agent has dried.
e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
b. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

a. Correct low and high areas.
b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.

a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
d. Place, compact, and finish to blend with adjacent finished concrete.
e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
b. Dampen cleaned concrete surfaces and apply bonding agent.
c. Place patching mortar before bonding agent has dried.
d. Compact patching mortar and finish to match adjacent concrete.
e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.12 FIELD QUALITY CONTROL

A. Special Inspections: Engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
2. Testing agency shall report results of tests and inspections, in writing, to Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:

1) Project name.
2) Name of testing agency.
3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
4) Name of concrete manufacturer.
5) Date and time of inspection, sampling, and field testing.
6) Date and time of concrete placement.
7) Location in Work of concrete represented by samples.
8) Date and time sample was obtained.
9) Truck and batch ticket numbers.

10) Design compressive strength at 28 days.
11) Concrete mixture designation, proportions, and materials.
12) Field test results.
13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

   a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

   a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.

   a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C1064/C1064M:

   a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.

5. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.

a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

6. Compression Test Specimens: ASTM C31/C31M:

a. Cast and laboratory cure two sets of two 6-inch by 12-inch cylinder specimens for each composite sample.
b. Cast, initial cure, and field cure two sets of two standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C39/C39M.

a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture 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 if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests:

a. 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.
b. 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.

1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 (ACI 301M), section 1.6.6.3.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness in accordance with ASTM E1155 (ASTM E1155M) within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.13 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

SECTION 040110
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. Work Results

B. Principal Products

C. Section includes cleaning the following:
   1. Unit masonry surfaces.
   2. Stone surfaces.
   3. Concrete 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. Remove plant growth.
   2. 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.
   3. Remove paint.
   4. 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 PAINT REMOVERS

A. Alkaline Paste Paint Remover: Manufacturer's standard alkaline paste or gel formulation, for removing paint from masonry; containing no methylene chloride.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABR Products, Inc.; 800 Brush Grade.
      b. Diedrich Technologies Inc.; 606 Multi-Layer Paint Remover or 606X Extra Thick Multi-Layer Paint Remover.
      c. EaCo Chem, Inc.; Stripper Cream.
      d. Hydrochemical Techniques, Inc.; HydroClean HT-716 Heavy Duty Paint Remover.
      e. PROSOCO, Inc.; Sure Klean Heavy Duty Paint Stripper or Sure Klean Heavy Duty Paint Stripper D.

B. Covered or Skin-Forming Alkaline Paint Remover: Manufacturer's standard covered or skin-forming, alkaline paste or gel formulation, for removing paint from masonry; containing no methylene chloride.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABR Products, Inc.; 800 Fast Acting Grip 'N Strip.
      b. Diedrich Technologies Inc., a division of Sandell Construction Solutions; 404 Rip-Strip.
      c. Dumond Chemicals, Inc.; Peel Away 1.
      d.

C. Solvent-Type Paste Paint Remover: Manufacturer's standard water-rinsable, solvent-type paste or gel formulation, for removing paint from masonry.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Diedrich Technologies Inc., a division of Sandell Construction Solutions; 505 Special Coatings Stripper.
      b. Hydrochemical Techniques, Inc.; HydroClean HT-300 Solvent Paint Remover.

c. PROSOCO, Inc.; Sure Klean Fast Acting Stripper.

D. Low-Odor, Solvent-Type Paste Paint Remover: Manufacturer's standard low-odor, water-rinseable, solvent-type paste, gel, or foamed emulsion formulation, for removing paint from masonry; containing no methanol or methylene chloride.
1. Products: Subject to compliance with requirements, provide one of the following:
a. ABR Products, Inc.; ABR Citrus Paint Removers or Super Bio Strip Gel.
b. Cathedral Stone Products, Inc.; S-301, , S-303, or S-305.
c. Dumond Chemicals, Inc.; Peel Away 7 without paper covering or Smart Strip Pro.
d. EaCo Chem, Inc.; InStrip.
e. PROSOCO, Inc.; Enviro Klean SafStrip or Enviro Klean SafStrip 8.

E. Covered, Solvent-Type Paste Paint Remover: Manufacturer's standard, low-odor, covered, water-rinsable, solvent-type paste or gel formulation, for removing paint coatings from masonry; containing no methanol or methylene chloride.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Dumond Chemicals, Inc.; Peel Away 6 or Peel Away 7.
b. PROSOCO, Inc.; Enviro Klean Safety Peel 1.

2.2 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 or Safe n' Easy Limestone 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 or Stand Off Liquid Marble Cleaner.
h.

G. Acidic Cleaner: Manufacturer's standard acidic masonry cleaner composed of hydrofluoric acid or ammonium bifluoride blended with other acids, detergents, wetting agents, and inhibitors.
1. Products: Subject to compliance with requirements, provide one of the following:
a. ABR Products, Inc.; 801 Heavy Duty Masonry Cleaner.
b. Diedrich Technologies Inc.,; Diedrich 101 Masonry Restorer or Diedrich 101G Granite, Terra Cotta, & Brick Cleaner.
c. Dumond Chemicals, Inc.; Safe n' Easy Heavy Duty Restoration Cleaner.
d. EaCo Chem, Inc.; Glazed Surface Restoration Detergent.
e. Hydrochemical Techniques, Inc.; HydroClean HT-626 Brick, Granite, Sandstone & Terra Cotta Cleaner.
f. Price Research, Ltd.; Price Restoration Cleaner.
g. PROSOCO, Inc.; Enviro Klean EK Restoration Cleaner, Enviro Klean SafRestorer, Sure Klean Heavy-Duty Restoration Cleaner-NE, or Sure Klean Restoration Cleaner.

H. One-Part Limestone Acidic Cleaner: Manufacturer's standard one-part acidic formulation for cleaning limestone.
1. Products: Subject to compliance with requirements, provide one of the following:
a. ABR Products, Inc.; X-190 Limestone & Concrete Cleaner.
b. EaCo Chem, Inc.; HD Britenol orOneRestore
c. Hydrochemical Techniques, Inc.; HydroClean HT-907 Limestone and Marble Cleaner & Brightener.
d. Price Research, Ltd.; Price Limestone Restorer.
e. PROSOCO, Inc.; Sure Klean Limestone Restorer.
f.

I. Two-Part Chemical Cleaner: Manufacturer's standard system consisting of potassium- or sodium-hydroxide-based, alkaline prewash cleaner and acidic afterwash cleaner that does not contain hydrofluoric acid. Products: Subject to compliance with requirements, provide one of the following
1. Products: Subject to compliance with requirements, provide one of the following:
a. Diedrich Technologies Inc.; Diedrich 707X Limestone Cleaner Pre-Rinse Diedrich 808X Black Encrustation Remover - Super Strong followed by 707N Limestone Neutralizer After-Rinse.
b. Hydrochemical Techniques, Inc.; HydroClean HT-704X Heavy Duty Limestone & Marble Precleaner and HydroClean HT-907 Limestone and Marble Cleaner & Brightener.
c.
d. PROSOCO, Inc.; Enviro Klean BioKlean or Sure Klean 766 Limestone & Masonry Prewash followed by Sure Klean Limestone & Masonry Afterwash.

2.3 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.

2.4 CHEMICAL CLEANING SOLUTIONS

A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.

B. Acidic Cleaner Solution for Nonglazed Masonry and Unpolished Stone: Dilute acidic cleaner with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended in writing by chemical-cleaner manufacturer.
   1. Stones: Use only on unpolished granite, unpolished dolomite marble, and siliceous sandstone.

C. Acidic Cleaner for Glazed Masonry and Polished Stone: Dilute acidic cleaner with water to concentration demonstrated by testing that does not etch or otherwise damage glazed or polished surface, but not greater than that recommended in writing by chemical-cleaner manufacturer.
   1. Stones: Use only on polished granite and polished dolomite marble.

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 high-pressure water-spray application, use fan-shaped spray that disperses water at an angle of at least 40 degrees.
      e. 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.
      f. For steam application, use steam generator capable of delivering live steam at nozzle.

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. Steam Cleaning: Apply steam to masonry surfaces at the very low pressures indicated for each type of masonry. Hold nozzle at least 6 inches from masonry surface and apply steam in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.

H. 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.

I. 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.

J. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

3.3 PRELIMINARY CLEANING

A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and plant debris from open joints to whatever depth they occur.

B. 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 wit 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 PAINT REMOVAL

A. Paint-Remover Application, General: Apply paint removers according to paint-remover manufacturer's written instructions. Do not allow paint removers to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.

B. Paint Removal with Alkaline Paste Paint Remover:

1. Remove loose and peeling paint using low-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with brushes.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with hot water applied by low-pressure spray to remove chemicals and paint residue.
5. Repeat process if necessary to remove all paint.
6. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
7. Rinse with cold water applied by low-pressure spray to remove chemicals and soil.

C. Paint Removal with Covered or Skin-Forming Alkaline Paint Remover:
1. Remove loose and peeling paint using low pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.
4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with hot water applied by low-pressure spray to remove chemicals and paint residue.
7. Apply acidic cleaner or manufacturer's recommended afterwash to surface, while surface is still wet, using low-pressure spray equipment or soft-fiber brush. Let cleaner or afterwash remain on surface as a neutralizing agent for period recommended in writing by chemical-cleaner or afterwash manufacturer.
8. Rinse with cold water applied by low-pressure spray to remove chemicals and soil.
9. For spots of remaining paint, apply alkaline paste paint remover, according to "Paint Removal with Alkaline Paste Paint Remover" Paragraph.

D. Paint Removal with Solvent-Type Paste Paint Remover:
1. Remove loose and peeling paint using low-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply thick coating of paint remover to painted surface with natural-fiber cleaning brush, deep-nap roller, or large paint brush. Apply in one or two coats according to manufacturer's written instructions.
3. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
4. Rinse with hot water applied by low-pressure spray to remove chemicals and paint residue.

E. Paint Removal with Covered, Solvent-Type Paste Paint Remover:
1. Remove loose and peeling paint using low-pressure water spray, scrapers, stiff brushes, or a combination of these. Let surface dry thoroughly.
2. Apply paint remover to dry, painted surface with trowel, spatula, or as recommended in writing by manufacturer.
3. Apply cover according to manufacturer's written instructions.

4. Allow paint remover to remain on surface for period recommended in writing by manufacturer or as determined by preconstruction testing.
5. Scrape off paint and remover.
6. Rinse with hot water applied by low-pressure spray to remove chemicals and paint residue.

3.5 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
4. .
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.

H. Mild-Acid Chemical Cleaning:
1. Wet surface with cold 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.
4. Rinse with cold water applied by low-pressure spray to remove chemicals and soil.
5. 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.
6. Wet surface with hot water applied by low-pressure spray.
7. Apply cleaner to surface by brush or low-pressure spray.
8. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer.

I. One-Part Limestone Chemical Cleaning:
1. Immediately repeat application of one-part limestone cleaner as indicated above over the same area.
2. Rinse with hot water applied by medium-pressure spray to remove chemicals and soil.

J. Two-Part Chemical Cleaning:
1. Wet surface with hot water applied by low-pressure spray.
2. Apply alkaline prewash cleaner to surface by brush or roller.
3. Let cleaner remain on surface for period recommended in writing by chemical-cleaner manufacturer unless otherwise indicated.
4. Rinse with hot water applied by medium-pressure spray to remove chemicals and soil.
5. Apply acidic afterwash cleaner to surface in two applications, while surface is still wet, using low-pressure spray equipment, deep-nap roller or soft-fiber brush. Let neutralizer remain on surface for period recommended in writing by manufacturer unless otherwise indicated.

6. Rinse with cold water applied by medium-pressure spray to remove chemicals and soil. Rinse until surface reaction value is between pH 5 and pH 9 according to pH-measuring paper, pen, or indicator solution.
7. Repeat cleaning procedure above where required to produce cleaning effect established by mockup. Do not repeat more than once.

3.6 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.

3.7 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 paint-remover manufacturer's and 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 paint-remover manufacturer's and chemical-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 040120.63
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. Work Results

B. Principal Products

C. Section Includes:
1. Repairing brick masonry.
2. Removing abandoned anchors.
3. Painting steel uncovered during the work.

D. Related Requirements:
1. Section 01 35 16 "Alteration Project Procedures" for general remodeling, renovation, repair, and maintenance requirements.

1.3 ALLOWANCES

A. Allowances for brick masonry repair are specified in Section 01 21 00 "Allowances."

B. Preconstruction testing is part of testing and inspecting allowance.

C. Abandoned anchor removal is part of Abandoned Anchor Removal & Patching.

D. Brick removal and replacement is part of brick removal and replacement allowance.

E. Patching brick masonry is part of masonry patching allowance.

1.4 UNIT PRICES

A. Work of this Section is affected by unit prices specified in Section 01 22 00 "Unit Prices."
1. Unit prices apply to authorized work covered by quantity allowances.
2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

1.5 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.

1.6 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

1.7 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. Retain and revise subparagraphs below and insert others to suit Project. Brick samples are not included because the existing brick is typically the standard of appearance, but brick samples for selection could be inserted. Revise options in "Colored Mortar" Subparagraph to approximate existing joint widths.
   2. 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.
   3. Sand Types Used for Mortar: Minimum 8 oz. (240 mL) of each in plastic screw-top jars.
   4. 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.

1.8 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, existing bricks and existing mortar.

C. Quality-control program.

1.9 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.

1.10 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.
   5. Temporary Patch: As directed by Architect, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

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.

1.11 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.

1.12 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. Special Shapes:
      a. Provide molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.
      b. Provide specially ground units, shaped to match patterns, for arches and where indicated.
      c. Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are unacceptable procedures for fabricating special shapes.
   3. Tolerances as Fabricated: According to tolerance requirements in ASTM C 216, Type FBS.

B. Building (Common) Brick: ASTM C 62, back-up construction.
   1. Classification: Grade SW
      a. Compressive Strength: 5,000 psi minimum average
      b. Saturation Coefficient: 0.78 maximum
         1) The absorption alternate in ASTM 216 shall not be allowed unless specifically approved by the Architect.
      c. Initial Rate of Absorption: between 5 and 25 grams per 30 square inches per minute.
      d. Efflorescence: brick rated as "not efflorescent" per ASTM C67
   2. Size: Modular or Standard Size.

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. Dovetail Anchors: ASTM A82 and ASTM A153-B2
   1. Dovetail: Min 12 gauge sheet metal, 1-inch wide.
   2. Anchor Wire: 3/16" Triangular tie
   3. Length: Dovetail tab and anchor length as required to fit existing construction.
   4. Finish: Stainless steel, Type 304 or 316

C. 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.

D. 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.

E. 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.

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 042000
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. Work Results

B. Principal Products

C. Section Includes:
1. Concrete masonry units.
2. Clay face brick.
3. Mortar and grout.
4. Steel reinforcing bars.
5. Masonry-joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.

D. Products Installed but not Furnished under This Section:
1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.
3. Cavity wall insulation.

E. Related Requirements:
1. Section 03 30 00 "Cast-in-Place Concrete" for installing dovetail slots for masonry anchors.
2. Section 05 12 00 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 07 21 00 "Thermal Insulation" for cavity wall insulation.
4. Section 07 62 00 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
5. Section 09 75 19 "Stone Trim" for stone window stools.
6. 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 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 down face next to unconstructed wythe, and hold cover in place.

B. 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.

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 TMS 602/ACI 530.1/ASCE 6.
   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 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 units for outside corners unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent .
   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. HYPERLINK "http://www.specagent.com/Lookup?ulid=9954" 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: .
   3. Size (Width): Manufactured to dimensions 3/8 inch 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-wide returns of facing to create 1/4-inch-wide mortar joints with modular coursing.
   4. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.4 [CONCRETE][MASONRY] LINTELS

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.
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
   3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
   4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C 216.

C. COORDINATE GRADE, TYPE, SIZE AND COLOR SELECTION WITH BRICK SELECTED FOR PROJECT.
   1. Grade: SW.
   2. Type: FBS.
   3. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of .
   4. Initial Rate of Absorption: Less than 30 g/30 sq. in. 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.

D. COORDINATE GRADE, TYPE, SIZE AND COLOR SELECTION WITH BRICK SELECTED FOR PROJECT.
   1. ASTM C216: Grade SW.
   2. ASTM C 216: Type FBS.

3. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of .
4. Nominal Size: As indicated on Drawings.
5. Provide Type I (single-faced units) where only one finished face is exposed when units are installed, and Type II (double-faced units) where two opposite finished faces are exposed when units are installed.
6. Application: Use where indicated.
7. Colors: Match Architect's samples.

2.6 STRUCTURAL CLAY FACING TILE

2.7 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.
      d.
   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.
      b. Brick Type B: Manufacturer's standard color as selected by the Architect.
      c. Brick Type C: 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 thick, use aggregate graded with 100 percent passing the No. 16 sieve.
   3. For joints less than 3/8 inch thick, use aggregate graded with 100 percent passing the No. 8 sieve and 95% passing the No. 16 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. HYPERLINK "http://www.specagent.com/Lookup?ulid=4043" 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.

2.8 REINFORCEMENT

A. IF REMOTE WALL, FREE STANDING WALL, TRASH ENCLOSURE OR CORROSIVE ENVIRONMENT EXPOSED TO WEATHER CONSIDER EPOXY COATED REINFORCING BARS. SHOW ON DRAWINGS.

B. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M, Grade 60.

C. 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 steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

D. 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 diameter.
   4. Wire Size for Cross Rods: 0.148-inch diameter.
   5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
   6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

E. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

F. 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 and maximum vertical adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

2.9 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch 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-diameter, hot-dip galvanized steel wire.
   2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-, 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-thick steel sheet, galvanized after fabrication.
   2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, hot-dip galvanized steel wire.

E. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.105-inch-thick steel sheet, galvanized after fabrication.
3. Fabricate wire ties from 0.187-inch- 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. HYPERLINK "http://www.specagent.com/Lookup?ulid=10035" 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. HYPERLINK "http://www.specagent.com/Lookup?ulid=10036" 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 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.

2.10 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 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; .

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.

2.11 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 the following unless otherwise indicated:
1. Wicking Material: Absorbent rope, made from cotton, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches 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 less than depth of outer wythe, in color selected from manufacturer's standard.
a. HYPERLINK "http://www.specagent.com/Lookup?ulid=10034" 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 thick and 10 inches (250 mm) high, designed to catch mortar droppings and prevent weep holes from clogging with mortar.

2.12 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.

2.13 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.
3. Provide grout with a slump of 8 to 11 inches 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 or minus 1/4 inch.
   2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
   3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch 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, or 1/2-inch 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, 1/4 inch in 20 feet, or 1/2-inch maximum.
   3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch 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, 1/4 inch in 20 feet, or 1/2-inch maximum.
   5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
   6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2-inch maximum.
   7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch 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, with a maximum thickness limited to 1/2 inch.
   2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
   3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
   4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
   5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch 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 ; do not use units with less-than-nominal 4-inch 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. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch 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 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. Set trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
   1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
   2. Allow cleaned surfaces to dry before setting.
   3. Wet joint surfaces thoroughly before applying mortar.
   4. Rake out mortar joints for pointing with sealant.

C. Rake out mortar joints at to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.

D. 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 or more in width.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

F. Cut joints flush where indicated to receive unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together:
   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. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches 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 with masonry-veneer anchors to comply with the following requirements:
   1. Fasten anchors with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
   2. Embed 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 o.c. vertically and 25 inches o.c. horizontally, with not less than one anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

B. Provide not less than 2” of airspace between back of masonry veneer and face of CMU
   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 on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Unless otherwise indicated on drawings or specified under specific wall type, space reinforcement not more than 16 inches o.c.
   2. Unless otherwise indicated on drawings or specified under specific wall type, space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
   3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches 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 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 o.c. vertically and 36 inches 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 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 for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

C. 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 lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches 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.

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, and 1-1/2 inches 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; with upper edge tucked under air barrier, lapping at least 4 inches.
   4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
   5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches 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 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 o.c. unless otherwise indicated.
   4. Space weep holes formed from wicking material 16 inches 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

3.14 PARGING

3.15 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 no masonry 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."

3.16 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.

3.17 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 051200 - STRUCTURAL STEEL 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. Structural steel.
2. Shrinkage-resistant grout.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other steel items not defined as structural steel.
4. Section 099113 "Exterior Painting" for painting requirements.
5. Section 099123 "Interior Painting" for painting requirements.

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

D. Demand-Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the seismic-load-resisting system and which are indicated as "demand critical" or "seismic critical" on Drawings.

1.4 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Site.

1.6 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Anchor rods.
4. Threaded rods.
5. Slide bearings.
6. Shop primer.
7. Galvanized-steel primer.
8. Galvanized repair paint.
9. Shrinkage-resistant grout.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand-critical welds.
8. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated-Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural-steel materials, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.

F. Survey of existing conditions.

G. Source quality-control reports.

H. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

C. Shop-Painting Applicators: Qualified in accordance with AISC's Sophisticated Paint Endorsement P1 or to SSPC-QP 3.

D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. ANSI/AISC 341.
3. ANSI/AISC 360.
4. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Design connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer. Member reinforcement at connections is indicated on Drawings.

a. Use Load and Resistance Factor Design; data are given at factored-load level.

C. Moment Connections: Type FR, fully restrained.

D. Construction: Moment frame.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M.

B. Channels, Angles, M , S-Shapes: ASTM A36/A36M.

C. Plate and Bar: ASTM A36/A36M.

D. Corrosion-Resisting (Weathering) Structural-Steel Shapes, Plates, and Bars: ASTM A588/A588M, 50 ksi (345 MPa).

E. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.

F. Corrosion-Resisting (Weathering), Cold-Formed Hollow Structural Sections: ASTM A847/A847M structural tubing.

G. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

1. Weight Class: Standard.
2. Finish: Black except where indicated to be galvanized.

H. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.

I. Steel Forgings: ASTM A668/A668M.

J. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1 (Type 8.8-1), compressible-washer type with plain finish.

B. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

A. Headed Anchor Rods: ASTM F1554, Grade 36, straight.

1. Nuts: ASTM A563 (ASTM A563M) heavy-hex carbon steel.
2. Plate Washers: ASTM A36/A36M carbon steel.
3. Washers: ASTM F436 (ASTM F436M), Type 1, hardened carbon steel.
4. Finish: Plain.

B. Threaded Rods: ASTM A36/A36M.

1. Nuts: ASTM A 63 (ASTM A563M) heavy-hex carbon steel.
2. Washers: ASTM F436 (ASTM F436M), Type 1, hardened carbon steel.
3. Finish: Plain.

2.5 SLIDE BEARINGS

A. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.
   1. Mating Surfaces: PTFE and PTFE.
   2. Coefficient of Friction: Not more than 0.03.
   3. Design Load: Not less than 5,000 psi.
   4. Total Movement Capability: 2 inches.

2.6 PRIMER

A. Steel Primer:

   1. Comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
   2. SSPC-Paint 23, latex primer.
   3. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer: MPI#80.

   1. Etching Cleaner: MPI#25, for galvanized steel.
   2. Galvanizing Repair Paint: ASTM A780/A780M.

2.7 SHRINKAGE-RESISTANT GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.8 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 1.

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.9 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: Pretensioned.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.10 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize lintels, shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

2.11 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
2. Surfaces to be field welded.

3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces unless indicated to be painted.
6. Corrosion-resisting (weathering) steel surfaces.
7. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7 (WAB)/NACE WAB-4.
4. SSPC-SP 14 (WAB)/NACE WAB-8.
5. SSPC-SP 11.
6. SSPC-SP 6 (WAB)/NACE WAB-3.
7. SSPC-SP 10 (WAB)/NACE WAB-2.
8. SSPC-SP 5 (WAB)/NACE WAB-1.
9. SSPC-SP 8.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.

1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E165/E165M.
    b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    c. Ultrasonic Inspection: ASTM E164.
    d. Radiographic Inspection: ASTM E94/E94M.

4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

    a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
    b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.

5. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.

3. Pretension anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: Pretensioned.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.

3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1) Liquid Penetrant Inspection: ASTM E165/E165M.
2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3) Ultrasonic Inspection: ASTM E164.
4) Radiographic Inspection: ASTM E94/E94M.

3.6 PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting."

D. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 051200

SECTION 053100 - STEEL DECKING

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 deck.

B. Related Requirements:
1. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
2. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
3. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Calculations:

1. Submit engineering calculations by licensed structural engineer for the spans and loading conditions indicated for the deck proposed for use. Submit engineering calculations and manufacturer’s data verifying that the specified deck meets the design requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.

D. Evaluation Reports: For steel deck, from ICC-ES.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire-Resistance Ratings: Comply with ASTM E119; 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.

2.2 ROOF DECK

A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 40 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

    a. Color: Manufacturer's standard.
2. Deck Profile: Type WR, wide rib.
3. Profile Depth: As indicated.
4. Design Uncoated-Steel Thickness: As indicated.
5. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
6. Span Condition: Simple span.
7. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi , not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch wide flanges and level recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

L. Galvanizing Repair Paint: ASTM A780/A780M.

M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions prior to beginning work.

B. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: 5/8 inch, nominal.

2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 12 inches apart in the field of roof and 6 inches apart in roof corners and perimeter.
3. Weld Washers: Install weld washers at each weld location.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 18 inches, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of 1-1/2-inch long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

D. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Prepare test and inspection reports.

3.5 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces prime-painted deck immediately after installation, and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION 053100

SECTION 06 10 53

MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Concealed blocking and nailers.
2. Utility backboards.

B. Principal Products

1. Fire retardant treated lumber and panels.
2. Preservative treated lumber.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Wood preservative treatment.
2. Fire retardant treatment.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store lumber indoors, protected from elements.
2. Store lumber elevated above grade, protected from moisture.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber: DOC PS 20. Grading rules certified by ALSC Board of Review.

1. Maximum Moisture Content: 19 percent.

B. Plywood: DOC PS 1, Exterior A-C, fire-retardant treated.

1. Thickness: See Drawings.

C. Fire Retardant by Pressure Process:

1. Exterior Type: ASTM C2898.
2. Interior Type A: ASTM D3201, 28 percent maximum moisture content at 92 percent relative humidity.
3. Surface Burning Characteristics per ASTM E84.

    a. Flame Spread: 25
    b. Smoke Developed: 450.

4. Labeling: Testing agency classification.
5. Kiln-dry after treatment.

    a. Lumber: 19 percent maximum moisture content.
    b. Plywood: 15 percent maximum moisture content.

6. Applications:

    a. Concealed blocking.
    b. Plywood utility backing panels.
    c. Roof blocking.
    d. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
    e. Items shown on Drawings.

D. Wood Preservative (Pressure Treatment): AWPA U1 .

1. Applications:

    a. Roofing and Exterior Wall Assemblies: Wood cants, nailers, curbs, and blocking; Category UC2.
    b. Items shown on Drawings.

2.2 ACCESSORIES

A. Fasteners and Anchors:

1. General: Comply with requirements for wood member size and type.

    a. ACQ Preservative Treated Wood: Type 304 stainless steel.
    b. Other Applications: ASTM A153/A153M hot-dip galvanized.

2. Nails, Brads, and Staples: ASTM F1667.
3. Power-Driven Fasteners: NES NER-272.
4. Wood Screws: ASME B18.6.1.
5. Screws for Fastening to Metal Framing:

    a. Cold-Formed Metal Framing: ASTM C954.
    b. Other Metal Framing: ASTM C1002.

6. Anchors:

a. Toggle bolt type for anchorage to hollow masonry.
b. Expansion shield and lag bolt type for anchorage to solid masonry or concrete.
c. Bolt or ballistic fastener for anchorages to steel.

B. Separation Layer: Butyl Rubber and Rubberized asphalt flashing sheet membrane.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set members level and plumb, in correct position.

B. Place horizontal members crown side up.

C. Construct curb members of solid wood sections.

D. Fasten plywood backing panels to substrate with fire retardant classification marking exposed to view; coordinate locations with equipment requiring backing panels.

E. Install continuous flexible flashing separator as follows:

1. ACQ Wood-Preservative-Treated Lumber: Between wood and metal decking.
2. Without Preservative Treatment: Between wood and concrete or masonry.

F. Comply with AWPA M4 for site applied preservative treatment to cut surfaces of SBX preservative-treated lumber.

3.2 PROTECTION

A. Protection: Protect wood treated with inorganic boron (SBX) from weather. Apply EPA-registered borate treatment when inorganic boron-treated wood becomes wet. Apply borate solution by spraying. Comply with EPA-registered label.

END OF SECTION

SECTION 06 40 00

ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Plastic laminate Pantry cabinetry and casework.
2. Built in Plastic laminate and upholstered bench and quilted surround.
3. Built in Plastic laminate countertop with concealed support.
4. Built in Plastic laminate shelving at Lobby.
5. Custom Reception Desk

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Submittals - General:

1. Comply with AWI 100.

B. Certification Labels: AWI Quality Certification Program.

1. Project Registration Number: <Number>.

C. Product Data:

1. Panel products.
2. Adhesives.
3. Manufactured trim profiles and ornamental components.
4. Hardware.
5. Finish materials.
6. Shop primers.
7. Fire retardant treatment.
8. Initial selection color samples.

D. Shop Drawings:

1. Dimensioned plans and elevations showing architectural woodwork elements locations.

2. Show materials, profiles, assembly methods, joint details, fastening methods, hardware locations and sizes and locations of cutouts and finishes.

E. Samples:

1. Finished Material: Provide samples for each wood profile, species, and finish.

   a. Range Samples: Submit three each of light, medium and dark range stain samples for selection.
   b. Linear Elements: 12 inches long.
   c. Veneer Panels: 12 by 12 inches.

2. Plastic Laminates: 8 by 10 inches, minimum.
3. Upholstery Material: 12 inch square.
4. Hardware: Each type and finish.
5. Fabricated Samples:

   a. Plastic laminate applied to core material with edge banding, 8 by 10 inches, minimum.
   b. Cabinet corners: Illustrate joints between side panels, frames, doorsand drawers.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports: Independent testing agency test results showing:

1. Performance of fire-retardant-treated wood.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For architectural woodwork. .

B. Warranty Documentation: For manufactured products. .

1.6 QUALITY ASSURANCE

A. Fabrication Standard

1. Comply with AWI Architectural Woodwork Standards.

B. Qualifications:

1. Fabricators: Shop employing workers skilled in custom fabricating items similar to those required for Project.
2. Installer: Fabricator of woodwork.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements: Comply with AWI 200.

1.8 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.

B. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 FABRICATORS

A. Qualified Woodwork Fabricators:

1. <Provide list of approved fabricators>

2.2 MANUFACTURERS AND PRODUCTS

A. Manufacturers and Products: See Finish Schedule on Drawings.

2.3 WOODWORK GENERAL REQUIREMENTS

A. Quality Standard: Comply with AWI 300 - Materials and ANSI/AWI 0620 - Installation for aesthetic grades.

B. Woodwork Grade: Premium.

2.4 PLASTIC LAMINATE FACED CABINETS

A. Grade: Custom.

B. Cabinet Construction: Frameless.

C. Door and Drawer Configuration: Flush overlay.

1. Reveal Dimension: See Drawings.

D. Exposed Surfaces: High-pressure decorative laminate.

1. Horizontal Surfaces Other Than Tops: Grade HGS.
2. Postformed Surfaces: Grade HGP.
3. Vertical Surfaces: Grade HGS and VGS.
4. Edge Banding: 0.018 inch PVC tape matching exposed laminate.

E. Plastic Laminate

1. Manufacturers and Products: See Finish Schedule on Drawings.

F. Semiexposed Surfaces Other Than Drawer Bodies: Grade VGS HPDL.

1. Edge Banding: 0.018 inch PVC tape matching exposed laminate.

G. Drawer Bodies: Closed grain hardwood.

1. Edge Banding: 0.018 inch PVC tape matching exposed laminate.

H. Drawer Construction: Join drawer sides, backs, and subfronts with glued dovetail joints.

2.5 CABINET HARDWARE AND ACCESSORIES

A. General: Comply with BHMA A159.9.

B. Cabinet Hinges: Concealed (European) type.

C. Pulls: BHMA A159.9, B02011, back mounted, 5/16 inch diameter, 4 inches long.

D. Cabinet Shelf Supports:

1. Shelf Standards and Brackets: BHMA A156.9, B04102 standards; with shelf brackets, B04112.

E. Drawer Slides: BHMA A156.9. Side mounted extending under bottom edge of drawer; with polymer rollers, zinc-plated steel and epoxy-coated steel, full-overtravel-extension type.

1. Box Drawers 6 inches by 24 inches: Grade 1HD-100.

F. Drawer Slides: BHMA A156.9. Side mounted extending under bottom edge of drawer; with polymer rollers, zinc-plated steel, full-overtravel-extension type.

1. Box Drawers 6 inches by 24 inches: Grade 1.

G. Locks: Provide complete system for each lock, including removable lock core, cylinder body, and strike plates.

1. Cabinet Door Locks: BHMA A156.11, E07121.
2. Drawer Locks: BHMA A156.11, E07041.
3. Provide two keys for each lock.

H. Grommets: Plastic spring loaded cover and outer ring.

1. Color: Architect selected.

I. Hardware Finishes: BHMA A156.18.

1. Exposed Hardware:
2. Concealed Hardware: Manufacturer's standard.

2.6 MATERIALS

A. Wood Materials, General: Comply with AWI 300 for grade specified.

B. Panel Products:

1. Hardwood Plywood and Veneers: ANSI HPVA HP-1.
2. Particleboard: ANSI A208.1 Grade M-2 or better.
3. Medium Density Fiberboard: ANSI A208.2, Grade 130.
4. Hardboard: AHA 135.4, standard grade.

C. Interior Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber.

D. High-Pressure Decorative Laminate: NEMA LD 3.

E. Adhesives: Recommended by facing material manufacturers and complying with VOC limitations.

F. Fasteners: Type, size, and material to suit each application.

2.7 LUMBER AND PANEL MATERIAL TREATMENT

A. Wood Preservative Pressure Treatment:

1. Interior Items: AWPA U1; Use Category UC2.

B. Fire-Retardant Treatment:

1. Chemically treated and pressure impregnated.
2. Flame Spread: 25, maximum per ASTM E84.
3. Label or otherwise identify fire retardant treated material.
4. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.

2.8 Seat cushion

A. Foam

1. Material: Polyurethane foam
2. Thickness: See drawings
3. Edge Profile : see drawings
4. Density: Medium
5. Secure loose cushions to supporting structure with concealed fasteners to fix cushions in place and in alignment. Fasteners shall be removed from cushions to allow cleaning and replacement.

B. Fasteners

2.9 FABRICATION

A. Shop assemble work for delivery to site, permitting passage through building openings.

B. When necessary to cut and fit on site, fabricate materials with ample allowance for cutting. Furnish trim for scribing and site cutting.

C. High-Pressure Decorative Laminate-Finished Faces:

1. Apply HPDL in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; conceal with concealed fasteners.
2. Apply laminate backing sheet to reverse face of HPDL finished surfaces.

D. Seat Cushions:

1. Secure loose cushions to supporting structure with concealed fasteners to fix cushions in place and in alignment. Fasteners shall be removed from cushions to allow cleaning and replacement.
2. Upholstery Material: Install material using application methods and fasteners recommended by the manufacturer for a smooth and even surface. Provide sufficient tension so upholstered surface is free of ripples, scallops, or puckers. Conceal seams in intersecting surfaces or channels

    a. Install upholstery material in the same direction with pattern on seat and back cushions matched and aligned.
    b. Seat cushion covers shall be removable.
    c. Covered Welt Cords: Install straight and true to building lines and adjacent construction. Install vertical welts parallel to each other. Place seams in welt-cord covering on sides or rear of seating units only.

E. Quilted Fabric Surround Panels

1. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
2. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.
3. Facing Material and Lining Material : Apply fabric fully covering visible surfaces of panel; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

    a. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.

4. Dimensional Tolerances of Finished Panels: Plus or minus 1/16 inch.

F. Fabrication Tolerances: ANSI/AWI 0620, specified grade.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with woodwork.

3.2 PREPARATION

A. Surface Preparation: Comply with ANSI/AWI 0620.

3.3 INSTALLATION - GENERAL

A. Follow ANSI/AWI 0620.

B. Installation Grade: Custom.

3.4 INSTALLATION

A. Install woodwork plumb and level.

B. Scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.

C. Install trim with adhesive or fine, finishing nails.

D. Cabinets:

1. Anchor wall cabinets to in-wall blocking or with cleats hanging attached to substrates. Secure with wafer-head cabinet installation screws.
2. Secure cabinets to floor using appropriate angles and anchorages.
3. Install finish hardware not installed in shop.

E. Quilted Fabric Surround Panels

1. Install panels in locations indicated. Unless otherwise indicated, install panels with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
2. Comply with manufacturer's written instructions for installation of panels using type of mounting devices indicated. Mount panels securely to supporting substrate.
3. Align fabric pattern and grain with adjacent panels.

3.5 ADJUSTING

A. Test installed work for rigidity and ability to support loads.

B. Lubricate and adjust hardware so doors and drawers operate smoothly.

3.6 CLEANING

A. Cleaning: Clean exposed and semiexposed surfaces of woodwork.

B. Touch up shop-applied finishes. Replace damaged items that cannot be repaired..

3.7 PROTECTION

A. Protection: Provide protection of millwork to Substantial Completion.

END OF SECTION

SECTION 070150.19
PREPARATION FORREROOFING

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. Work Results

B. Principal Products

C. Section Includes:
1. Full tear-off of entire roof system.
2. Removal of flashings and counterflashings.
3. Temporary roofing.

D. 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 52 16 - Styrene-Butadiene Styrene (SBS) Modified Bituminous Membrane 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: 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: SBS-modified bituminous 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.
   1. The results of an analysis of test cores from existing roofing system are available for Contractor's reference.

F. Limit construction loads on existing roof areas to remain, and existing roof areas scheduled to be reroofed. Verify load limits with contractor's structural engineer.

G. 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.

H. 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.

I. 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.

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty issued by manufacturer for existing warranted roof system.
   1. Notify warrantor before proceeding with the Work.
   2. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect.
      a. Submit documentation at Project closeout.

PART 2 PRODUCTS

2.1 TEMPORARY ROOFING MATERIALS

A. Use Vapor Retarder specified in Section 07 52 16 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing" 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. Steel deck is specified in Section 05 31 00 "Steel Decking."

C. Wood blocking, curbs, and nailers are specified in Section 06 10 00 "Rough Carpentry."

D. Plywood roof sheathing is specified in Section 06 16 00 "Sheathing."

E. 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 facilitate rapid 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 aggregate ballast from roofing.

D. Remove loose aggregate from aggregate-surfaced, built-up bituminous roofing using a power broom.

E. Remove pavers and accessories from roofing.
1. Store and protect pavers and accessories for reuse in manner not to exceed structural loading limitations of roof deck.
2. Discard cracked pavers.

F. Full/Partial Roof 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. Remove excess asphalt from steel deck.
      a. A maximum of 15 lb/100 sq. ft. (0.72 kg/sq. m) of asphalt is permitted to remain on steel decks.

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.

B. Prepare temporary roof to receive new roofing according to approved temporary roofing proposal
   1. Restore temporary roofing to watertight condition.
   2. Obtain approval for temporary roof substrate from roofing manufacturer and Architect before installing new roof.

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 FASTENER PULL-OUT TESTING

A. Perform fastener pull-out tests according to SPRI FX-1 and submit test report to the Architect and the roofing manufacturer before installing new roofing system.
   1. Obtain roofing manufacturer's approval to proceed with specified fastening pattern.

3.7 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 071800
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. Work Results

B. Principal Products

C. 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. Subject to compliance with requirements, provide products by one of the following:
      a. .
      b. Carlisle.
      c. .
      d. .
      e. .

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 D4258.
   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 072100
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. Work Results

B. Principal Products

C. Section Includes:
   1. Extruded polystyrene foam-plastic board.
   2. Polyisocyanurate foam-plastic board.
   3. Glass-fiber board.

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. Subject to compliance with requirements, provide products by one of the following:
      a. .
      b. .
      c. .
   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. Subject to compliance with requirements, provide products by one of the following:
      a. .
      b. .
   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. Subject to compliance with requirements, provide products by one of the following:
      a. .
      b. .
      c. .
   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. Subject to compliance with requirements, provide products by one of the following:
      a. .
      b. .
   2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

2.3 GLASS-FIBER BOARD

A. 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 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. Subject to compliance with requirements, provide products by one of the following:
   a. .
   b. .
   c. .

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. Subject to compliance with requirements, provide products by one of the following:
   a. .
   b. .
   c. .

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. Subject to compliance with requirements, provide products by one of the following:
   a. .
   b. .
   c. .

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. Subject to compliance with requirements, provide products by one of the following:
   a. .
   b. .
   c. .

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 in place.
   1. Subject to compliance with requirements, provide products by one of the following:
      a. .
      b. .
   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. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
   1. Subject to compliance with requirements, provide products by one of the following:
      a. .
      b. .

C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.
   1. Subject to compliance with requirements, provide products by one of the following:
      a. .
      b. .

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.

B. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: 2 outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or polyester scrim and weighing not less than 22 lb/1000 sf. Ft., with maximum permeance rating of 0.1317 perm and with flame-spread and smoke-developed indexes of not more than 5 and 60, respectively.
   1. Products:
      a. Raven Industries Inc.; DURA-SKRIM 2FR.
      b. Reef Industries, Inc.; Griffolyn T-55 FR.

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 INSTALLATION OF CAVITY-WALL INSULATION

A. Install boards to fit snugly between wall ties.

B. Install boards horizontally on walls.

C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane. Use closed cell insulation to fill any gaps or voids in the insulation.

3.4 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 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 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 INFORMATIONAL 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.

DELETE BELOW IF NOT REQUIRED.

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.

INCLUDE BELOW AS REQUIRED.

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.

CONFIRM BELOW REQUIREMENT WITH THE CHA PM DURING DESIGN. RETAIN AS REQUIRED.

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 075216
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. Work Results

B. Principal Products

C. 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.
8. Reflective Coating

D. 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.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

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, and 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 years 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): <Insert lbf/sq. ft.>.
   2. Zone 2 (Roof Area Perimeter): <Insert lbf/sq. ft.>.
      a. Location: From roof edge to <Insert dimension> inside roof edge.
   3. Zone 3 (Roof Area Corners): <Insert lbf/sq. ft.>.
      a. Location: <Insert dimension> 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. : 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 COATING MINERALS

A. Acrylic Roof Coating: Non-fiber, semi-gloss, one-part, water-based acrylic roof coating meeting reflectivity requirements.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Johns Manville: Topgard 4000
      b. Soprema, Inc.: Aslan Coating AC 401
      c. Tremco Incorporated: T24 Coating
      d. Garland Roofing: Pyramic

2.7 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

2.8 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. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).

D. Metal Termination Bars: Manufacturer's standard, pre-drilled stainless-steel, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

E. 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.

F. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.

G. 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.

H. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

2.9 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.

2.10 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.

2.11 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. ; ACFoam.
      b. ; FlintBoard
      c. ; 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.

2.12 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.

2.13 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.

2.14 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, 1/2 inch (13 mm) 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 deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.6 mm) out of plane relative to adjoining deck.
   5. 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 testprobes.
      b. Submit test reports within 24 hours of performing tests.
   6. Verify that any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
   7. Verify that adjacent cementitious wood-fiber panels are vertically aligned to within 1/8 inch (3 mm) at top surface.

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.

D. Perform fastener-pullout tests according to roof system manufacturer's recommendations.
   1. Submit test result within 24 hours of performing tests.

a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

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. At steel roof decks, install substrate board at right angle to flutes of deck.
      a. Locate end joints over crests of steel roof deck.
   2. Tightly butt substrate boards together.
   3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   4. 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. Nailer Strips: Mechanically fasten 4-inch nominal- (89-mm actual-) width, wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:
   1. 16 feet apart for roof slopes greater than 1 inch per 12 inches (1:12) but less than 3 inches per 12 inches (3:12).
   2. 48 inches apart for roof slopes greater than 3 inches per 12 inches (3:12).

D. 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.
         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. Mechanically attach base sheet to roof deck using mechanical fasteners specifically designed and sized for fastening base sheet to wood/wood panel decks.
      a. Fasten base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
   6. Install base sheet without wrinkles, rears, and free from air pockets.
   7. 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. Completely bond and seal laps, leaving no voids.
e. Roll laps with a 20-pound roller.

8. Repair tears and voids in laps and lapped seams not completely sealed.
9. 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.

D. Installation of Asphalt-Coated 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. Mechanically attach base sheet to roof deck using mechanical fasteners specifically designed and sized for fastening base sheet to wood/wood panel decks.
a. Fasten base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.
5. Adhere to substrate in a uniform coating of cold-applied adhesive.
6. Install base sheet without wrinkles or tears, and free from air pockets.
7. 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. Completely bond and seal laps, leaving no voids.
8. Repair tears and voids in laps and lapped seams not completely sealed.

3.10 INSTALLATION OF INTERPLY 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 (WHITE)

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: Chicago 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 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 076200
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. Work Results

B. Principal Products

C. 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.

D. Related Requirements:
1. Section 061053 "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 .

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 , shop shall be listed as able to fabricate required details as tested and approved.

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. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. 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.

E. 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.

F. 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. Copper Sheet: ASTM B370; temper H00, cold-rolled where temper 060 is required for forming.
   3. 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.

4. 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. : Subject to compliance with requirements, provide products by one of the following:
      a. ; CCW WIP 300HT.
      b. ; Grace Ice and Water Shield HT.
      c. ; 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 Copper Sheet: Copper, hardware bronze or passivated Series 300 stainless steel.
   3. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
   4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
   5. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.

C. Solder:
   1. For Copper: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead.
   2. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.

3. For Zinc-Coated (Galvanized) Steel: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead.

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. .
   2. Source Limitations: Obtain reglets from single source from single manufacturer.
   3. Material: Stainless steel, 0.019 inch (0.48 mm) thick.
   4. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   5. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
   6. 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.
   7. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
   8. 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.
   9. 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. Tin edges to be seamed, form seams, and solder.
2. 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.
3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

H. Do not use graphite pencils to mark metal surfaces.

2.6 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 with scuppers spaced 10 feet (3 m) apart, to dimensions required with 4-inch- (100-mm-) wide flanges and base extending 4 inches (100 mm) beyond cant or tapered

strip into field of roof. Fasten gravel guard angles to base of scupper.

3. 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. Copper: 20 oz./sq. ft. (0.68 mm thick)
   2. Aluminum: 0.040 inch (1.02 mm)
   3. Stainless Steel: 0.019 inch (0.48 mm)
   4. Galvanized Steel: 0.028 inch (0.71 mm)

E. Counterflashing: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft. (0.55 mm thick)
   2. Aluminum: 0.032 inch (0.81 mm)
   3. Stainless Steel: 0.019 inch (0.48 mm)
   4. Galvanized Steel: 0.022 inch (0.56 mm)

F. Flashing Receivers: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft. (0.55 mm thick)
   2. Aluminum: 0.032 inch (0.81 mm)
   3. Stainless Steel: 0.016 inch (0.40 mm)
   4. Galvanized Steel: 0.022 inch (0.56 mm)

G. Roof-Penetration Flashing: Fabricate from the following materials:
   1. Copper: 16 oz./sq. ft. (0.55 mm thick)
   2. Stainless Steel: 0.019 inch (0.48 mm)
   3. Galvanized Steel: 0.028 inch (0.71 mm)

H. Roof-Drain Flashing: Fabricate from the following materials:
   1. Copper: 12 oz./sq. ft. (0.41 mm thick)
   2. Stainless Steel: 0.016 inch (0.40 mm)

2.7 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. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch-(50-mm-) high, end dams. Fabricate from the following materials:
   1. Aluminum: 0.032 inch (0.81 mm)
   2. Stainless Steel: 0.016 inch (0.40 mm)

C. 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)

2.8 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)

B. Overhead-Piping Safety Pans: Fabricate from the following materials:
   1. Stainless Steel: 0.025 inch (0.64 mm)
   2. Galvanized Steel: 0.040 inch (1.02 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, and securely 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. Parapet Scuppers:

C. 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 or anchor and washer spaced at 12 inches (300 mm) o.c. along perimeter and 6 inches (150 mm) o.c. at co 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 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.

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 077100
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. Work Results

B. Principal Products

C. Section Includes:
1. Copings.
2. Roof-edge specialties.
3. Roof-edge drainage systems.

D. 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.

E. 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 .

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 D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      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. .
   b. .
   c. .
   d. .
   e. .
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 cornerunits.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. .
   b. .
   c. .
   d. .
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: Fascia extenders with continuous hold-down cleats, Wall cap, and Soffit trim.

5. .

2.4 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.

2.5 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. .
      b. .
      c. .
      d. .
   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.

2.6 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.

2.7 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.

B. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

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).

F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm); however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

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 or solder 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 077200
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. Work Results

B. Principal Products

C. Section Includes:
1. Roof curbs.
2. Roof hatches.
3. Pipe portals.
4. Cell phone equipment supports.
5. Fall protection / Roof davits
6. Roof handrails.

D. 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. .
   c. .

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: Zinc-coated (galvanized) steel sheet, 14 gage (0.0747 inch) thick.
   1. Finish: Baked enamel or powder coat.
   2. Color: As selected by Architect from manufacturer's full range.

E. Material: Aluminum sheet, 0.090 inch (2.28 mm) thick.
   1. Finish: Mill

F. 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 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.

2.4 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.

2.5 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. 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 079200
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. Work Results

B. Principal Products

C. Section Includes:
   1. Silicone joint sealants.
   2. Nonstaining silicone joint sealants.
   3. Urethane joint sealants.
   4. Mildew-resistant joint sealants.

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. Manufacturers: Subject to compliance with requirements, provide the following:
      a. Dow Corning Corporation; 790 Silicone Building Sealant
      b. Tremco Global Sealants; Spectrem 1 or Spectrem 3
      c. Pecora Corporation; 890 or 864
      d. ; SilPruf SCS-9000 NB or SilPruf SCS-2700.
      e. ; Sikasil WS-290 or Sikasil WS-290 FPS.

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. Manufacturers: Subject to compliance with requirements, provide the following:
   a. ; 756 SMS or 795.
   b. ; Spectrem 2 or Spectrem 3.
   c. ; 864NST or 895NST
   d. ; Silpruf SCS-2000 or SilPruf 9000 NB.
   e. ; 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. Manufacturers: Subject to compliance with requirements, provide the following:
   a. ; MasterSeal NP1.(class 35)
   b. ; Vulkem 116.
   c. ; Dynatrol I-XL.
   d. ; Sikaflex 1A.(class 35)

D. Type 4 -- Urethane, M, NS, 25, T, NT, A, M, O and I : Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Uses T, NT, A, M, I, and, as applicable to nonporous joint substrates indicated, O.

1. Manufacturers: Subject to compliance with requirements, provide the following:
   a. Pecora Corporation; DynaTred
   b. Sonneborn; Sonolastic NP2

E. Type 5 -- Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT, G, A, and, as applicable to nonporous joint substrates indicated, O.

1. Manufacturers: Subject to compliance with requirements, provide the following:
   a. ; 786-M.
   b. ; SCS1700 Sanitary.
   c. Pecora Corp.; 898NST.(class 50)
   d. ; Tremsil 200.

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: for adhesion of sealant to joint substrates

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 all 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 horizontal traffic surfaces Type 4.
   1. Joint Locations:
      a. Isolation and contraction joints in cast-in-place concrete slabs.
      b. Joints between plant-precast architectural concrete paving units.
      c. <Insert other joints>.
      d. Other joints as indicated on Drawings.
   2. Joint Sealant: Type 4.
   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 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.

C. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces Type 2.
   1. Joint Locations:
      a. Exterior Metal to Metal joints.
      b. Joints between metal panels.
      c. Joints between different materials listed above.
      d. Exterior perimeter joints between materials listed above and frames of doors, windows, and louvers.
      e. <Insert other joints>.
      f. 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.

D. Joint-Sealant Application: Interior joints in horizontal traffic surfaces Type 4.
   1. Joint Locations:
      a. Isolation joints in cast-in-place concrete slabs.
      b. Control and expansion joints in stone flooring.
      c. Control and expansion joints in brick flooring.
      d. Control and expansion joints in tile flooring.
      e. <Insert other joints>.
      f. Other joints as indicated on Drawings.
   2. Joint Sealant: Type 4.
   3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Joint-Sealant Application: Interior moving joints in vertical surfaces and horizontal nontraffic surfaces Type 1 and 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 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 and Type 3.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces Type 5.
1. Joint Locations:
a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
b. Tile control and expansion joints where indicated.
c. <Insert other joints>.
d. Other joints as indicated on Drawings.
2. Joint Sealant: Type 5.
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 SUMMARY

A. Work Results

1. Hollow metal doors and frames at various locations.
2. Hollow metal glazed doors at Vestibule.
3. Borrowed lite frames.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordinate Work of this Section with masonry partitions, gypsum board partitions, glass and glazing, acoustic sealant, and finish painting.

B. Preinstallation Meetings:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data.

1. Hollow metal doors and frames.
2. Factory Finishes: Color samples for initial selection.

B. Shop Drawings: Show construction, sizes, configurations, reinforcements, anchorages, installation details.

1. Door elevations showing cutouts.
2. Door frame elevations.
3. Hardware mounting locations.

C. Door Schedule:

1. Identify doors using same mark shown on Drawings.
2. Show door and frame types, sizes, ratings, glazing, and hardware sets.

D. Samples

1. Factory Finish: 3 by 5 inches, minimum applied to specified metal.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: SDI Certified.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store and handle door frames maintaining spreader bars in place until installation.

1.6 FIELD CONDITIONS

A. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Ceco Door
2. Curries.
3. Deansteel.
4. DCI.
5. Hollw Metal Xpress.
6. Mesker Door.
7. Metal Products Incorporated
8. Pioneer.
9. Premier Steel Frames and Doors.
10. Republic.
11. Steelcraft.
12. Or approved equal.

B. Substitutions: Permitted.

2.2 EXTERIOR DOORS AND FRAMES - EXTRA HEAVY DUTY

A. Doors: ANSI/SDI A250.8; 2 inch thick.

1. Applications: Other exterior doors.
2. Classification: Level 3, Physical Performance Level A.
3. Model: 2, seamless.
4. Faces: Steel sheet, 0.053 inch thick, G90 coating.
5. Core: Insulated.

6. Top and Bottom Edges: Closure channel, top edge sealed watertight.

B. Frames: ANSI/SDI A250.8.

1. Material: Steel sheet, 0.053 inch thick, coating matching door face.
2. Construction: Full profile welded, mitered corners.
3. Thermal Break: Manufacturer's standard.

2.3 INTERIOR DOORS AND FRAMES - HEAVY DUTY

A. Doors: ANSI/SDI A250.8; 1-3/4 inch thick.

1. Applications:
2. Classification: Level 3, Physical Performance Level A.
3. Model: 1, full flush.
4. Faces: Steel sheet, 0.042 inch thick, coating.
5. Fire Rated Door Core: Manufacturer's standard.
6. Other Door Core: Kraft paper honeycomb.

B. Frames: ANSI/SDI A250.8.

1. Material: Steel sheet, 0.053 inch thick, coating matching door face.
2. Construction: Full profile welded, mitered corners.

2.4 PERFORMANCE

A. Performance Requirements:

1. Exterior Doors: B2030.
2. Interior Doors: C1020.

B. Fire Resistance:

1. Test: NFPA 252 or UL 10C
2. Labeling: NFPA 80.
3. Glazing Size Limits: NFPA 80.

C. Environmental Performance: Exterior doors.

1. Air Infiltration: AAMA/WDMA/CSA 101/I.S.2/A440; 0.30 cfm/sf, maximum at 6.24 psf pressure differential.
2. Water Penetration: AAMA/WDMA/CSA 101/I.S.2/A440; no leakage at pressure differential.
3. Thermal Transmission: U-0.61, maximum.
4. Condensation Resistance:
5. Expansion and Contraction:

D. Acoustic Performance:

1. STC: ASTM E90; 35, minimum.

2.5 MATERIALS

A. Steel Sheet: ASTM A653/A653M; hot-dipped galvanealed for interior and galvanized for exterior coating.

B. Insulation:

1. Door Core: Polyurethane.
2. Door Frame: ASTM C665, Type 1, unfaced mineral fiber.

C. Fasteners: Manufacturer's standard

1. Steel Coating: ASTM A153/A153M hot-dipped galvanized.

2.6 FABRICATION

A. Fabricate doors and frames with hardware reinforcement welded in place.

1. Reinforce doors and frames for surface applied hardware without through bolting.
2. Hardware Locations: ANSI A250.8.

B. Door Edges: Beveled.

C. Frames within Masonry Openings:

1. Protect frame hardware preparations with mortar guard boxes.
2. Head: 4 inches aligning with coursing.

D. Attach astragal to one leaf of paired fire rated doors.

E. Reinforce frames wider than 48 inches with flush roll formed steel channels fitted tightly into frame head.

F. Prepare interior frames for silencers, except where smoke seals are specified.

1. Single Door Strike Jambs: 3 silencers.
2. Paired Door Heads: 2 silencers.

G. Frame Mullions for Double Doors:

1. Fixed: Profile matching jambs.
2. Removable: See Section 08 71 00.

H. Frame Transom Bars: Fixed, profile matching jamb.

I. Attach fire rating label to each fire rated door and frame.

1. Fire Rated Doors: Fire rating label.
2. Smoke Rated Doors: Smoke rating label.

J. Fabrication Tolerances

2.7 FINISHES

A. Primer Materials: ANSI/SDI A250.10, rust inhibiting.

B. Finish Materials: ANSI/SDI A250.3.

1. Color: Architect selected.

C. Painting

1. Liquid
2. Powder

2.8 ACCESSORIES

A. Removable Stops: Steel sheet, rolled channel shape, square corners.

B. Paired Door Astragals: Steel, T-shaped.

C. Galvanizing Repair Materials: ASTM A780/A780M.

D. Weatherstripping: See Section 08 71 00.

E. Silencers: See Section 08 71 00.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Verify opening sizes are within tolerance limits.

3.2 INSTALLATION

A. Install doors and frames. Follow ANSI/SDI A250.8.

1. Fire Rated Doors: NFPA 80.

B. Interface with Other Work:

1. Coordinate door frame and anchor installation with masonry, gypsum board, and concrete jamb construction.
2. Coordinate door and frame installation with door hardware installation. See Section 08 71 00. Install silencers before installing frame.
3. Coordinate removable stop installation with glass installation. See Section 08 80 00.

C. Install steel reinforcement channels between two abutting frames. Anchor channels to overhead structure and floor.

D. Install door louvers plumb and level.

E. Tolerances

1. Diagonal Distortion: 1/16 inch, maximum measured with straight edge, corner to corner.

F. Repair damaged zinc coatings. Follow ASTM A780/A780M.

G. Seal door frames to adjacent partition construction. See Section 07 92 00.

H. Field paint doors and frames. See Section 09 90 00.

3.3 ADJUSTING

A. Adjust door for smooth and balanced door movement.

B. Ensure fire rated doors self-close and latch.

END OF SECTION

SECTION 08 14 16

FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Wood doors at various location on Level 01.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate <work results of this Section> with <other work>.

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Each type of wood door; indicate veneer, core material, and finish.
2. Glazed openings.
3. Louvers.
4. Initial color charts.

B. Shop Drawings.

1. Each type of wood door. Include finishes.

C. Schedules: Use same designations as Drawings.

D. Samples:

1. Flush Doors: Corner construction with finished faces; 12 by 12 inches.
2. Casing Trim: Finished, 12 inch long.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports: Manufacturer test results showing:

1. Fire ratings.
2. STC.

B. Qualification Statements: Manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Warranty Documentation: For flush wood doors.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: SDI Certified.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Package doors individually; Do not allow to impact each other or scrape against other surfaces.
2. Identify doors on bottom edge and packaging with numbering system used on Drawings.
3. Do not deliver doors until building is enclosed.
4. Store doors and frames indoors.

1.8 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed, wet work complete, and environmental systems maintaining design conditions for Owner occupancy.

1.9 WARRANTY

A. Manufacturer Warranty:

1. Flush Wood Doors: Warrant against product failure.

a. Failure includes delamination, warping more than 1/4 inch, screw withdrawal, or telegraphing of core through veneer.
b. Warranty Period:

1) Interior Doors: Lifetime.
2) Exterior Doors: Five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Masonite Architectural.
2. TruStile.
3. VT Industries.
4. Or approve equal.

2.2 FLUSH WOOD DOORS - GENERAL

A. Quality Standard: ANSI/WDMA I.S. 1A “Industry Standard for Interior Architectural Wood Flush Doors,” Heavy Duty.

B. Fire Rated Wood Doors: NFPA 80; listed and labeled for required ratings based on testing at positive pressure per UL 10C.

1. Temperature Rise Limit Doors: 250 deg F above ambient, maximum transmitted temperature on faces not directly exposed to flame after 30 minutes of exposure.
2. Blocking: Composite blocking maintaining WDMA performance level and eliminating hardware through-bolting.
3. Vertical Edge Construction:

    a. Category A Positive Pressure: Integral intumescent seals concealed by outer stile
    b. Category B Positive Pressure: Intumescent seals applied to door frame per requirements of Section 08 71 00 Door Hardware.

4. Pairs:

    a. Fire-retardant stiles with concealed intumescent seals that are listed and labeled without formed steel edges and astragals.
    b. Formed steel edges and astragals with intumescent seals.

C. Smoke- and Draft-Control Doors: Listed and labeled per UL 1784.

D. Core Materials, Non-Fire-Rated Doors:

1. Particleboard: Wood-based particleboard; ANSI A208.4, Grade LD-2, meeting WDMA Performance Duty level specified without added blocking.
2. Structural Composite Lumber: WDMA T.M.10.
3. Stave lumber Core: WDMA I.S. 10.
4. Laminated veneer lumber core.

2.3 INTERIOR FLUSH WOOD DOORS FOR TRANSPARENT FINISH

A. WDMA Aesthetic Grade: Custom.

B. Faces: Veneer Grade Match existing..

1. Veneer Species: Match existing and Match existing.
2. Veneer Cut: Match existing.
3. Veneer Leaf Match: Match existing.
4. Veneer Face Match/Assembly: Match existing.

C. Pair Match: Provide for doors hung in same opening .

D. Thickness: 1-3/4 inches.

E. Applied Wood Moldings: Milled from solid wood.

1. Arrangement: See door elevations on Drawings.
2. Species: Same as face veneer.
3. Profile: Match existing.

2.4 FABRICATION

A. Factory Fitting: Fit to frame openings with clearances specified in WDMA I.S. 1A.

1. Undercut: 3/8 inch maximum above thresholds.
2. Fire-Rated Doors: Comply with NFPA 80.

B. Factory Machining: Machine doors for hardware that is not surface applied.

1. Verify dimensions for hardware mortises in metal frames before machining.

2.5 FINISHES

A. Finish Grade: Match grade of door.

B. Transparent Finish System: Match existing.

1. Staining: Match existing.
2. Sheen: Match existing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that door frames provided under other Specification sections are plumb, square, and accurate size.

B. Inspect each door before installation for damage and defects per WDMA Section F-6.

3.2 INSTALLATION

A. Installation Reference Standards:

1. Wood Doors: WDMA I.S. 1A.
2. Fire-Rated Doors: NFPA 80.
3. Smoke-and Draft-Control Doors: NFPA 105.

B. Hardware Installation: Section 08 71 00.

C. Align doors with uniform vertical and top edge clearance.

D. Verify that each door operates smoothly, do not bind in the frame, and have secure latching.

3.3 REPAIR

A. Repair of damage or defects is subject to Architect's acceptance, including removal of soiling. Provide replacement doors for doors that cannot be satisfactorily repaired.

3.4 CLEANING

A. Clean doors shortly before inspection for Substantial Completion.

END OF SECTION

SECTION 08 31 13

ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Access doors for accessing controls, valves, traps, dampers, cleanouts, and similar items requiring operation behind inaccessible finished surfaces.

B. Principal Products

1. Non-Rated, Recessed Access Doors with Concealed Flanges.
2. Fire-Rated, Flush Access Doors with Concealed Flanges.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate locations and sizes with various trades for proper placement of access doors. .

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment to other work.
2. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
3. Detail fabrication and installation of access doors and frames for each type of substrate.

C. Schedules: Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

D. CLOSEOUT SUBMITTALS

1. Project Record Documents: Record actual locations and sizes of access doors.

PART 2 - PRODUCTS

2.1 access doors and frames

A. Manufacturers:

1. Acudor Products, Inc.
2. J. L. Industries.
3. Karp Associates, Inc.
4. Nystrom, Inc.
5. Or approved equal.

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Non-Rated, Recessed Access Doors: At locations indicated on Drawings.

1. Door Configuration: Recessed 5/8 inch for gypsum board infill.
2. Locations: Walls and ceilings.
3. Uncoated Steel Sheet for Door: Nominal 0.060 inch.

    a. Finish: Factory prime.

4. Frame Material: Same material and thickness as door.
5. Flanges: Concealed in gypsum board compound and tape.
6. Hinges: Manufacturer's standard.

D. Fire-Rated, Flush Access Doors with Concealed Flanges: At locations indicated on Drawings

1. Assembly Description: Flush to frame, with mineral-fiber insulation core enclosed in sheet metal and frame with gypsum board beads for concealed flange installation
2. Latch: Self-latching door with automatic closer and interior latch release.
3. Locations: Walls and ceilings.
4. Fire-Resistance Rating: Match wall or floor-ceiling assembly.
5. Uncoated Steel Sheet for Door: Nominal 0.036 inches.

    a. Finish: Factory prime.

6. Frame Material: Same material thickness, and finish as door.
7. Hinges: Manufacturer's standard.

E. Hardware:

1. Cam Locks: Operated by spanner head or other special tool.

F. Maximum Door Sizes:

1. In wall, 16” x 16” square door: Plumbing valves, arrestors, hammers, reset buttons, controls manometers, and similar items.
2. In wall, 24” x 24” square door: Plumbing fittings at toilets, mechanical filters banks, access hatches, areas requiring work access for unit replacement, and similar items.

3. In ceiling, 24” x 24” square door: Above ceiling cut-off valves, duct dampers, fire or smoke dampers, meters, registers, and similar items.

2.2 performance

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.

2.3 materials

A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate per ASTM a 1008/A1008M, Commercial Steel (CS) exposed.

C. Frame Anchors: Same type as door face.

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.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Supply units with mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum board and gypsum base securely attached to perimeter of frames.
2. Provide mounting holes in frames for attachment of units to metal framing.

D. Latching Mechanisms: Number required to hold doors in flush, smooth plane when closed.

1. Supply two special tools.

2.5 finishes

A. Steel Finishes: Factory primed.

PART 3 - EXECUTION

3.1 examination

A. Verify rough openings for access doors and panels are correctly sized and located.

3.2 installation

A. Position units to provide convenient access to concealed work requiring access.

B. Secure frames rigidly in place, plumb and level in opening, with plane of door and panel face aligned with adjacent finished surfaces.

1. Set concealed frame type units flush with adjacent finished surfaces.

C. Install fire rated units in accordance with NFPA 80 and requirements for fire-resistance rating of wall or ceiling.

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 SUMMARY

A. Work Results

1. Aluminum framed entrances and storefronts at laundry Rooms
2. Aluminum glass door on existing storefront frame.

B. Principal products

1. Glazed aluminum storefront doors and frames

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Special Requirements: Transmit required submittals concurrently with submittals for the curtain wall system.

B. Product Data:

1. Storefront framing, included tested performances.
2. Window wall framing, including tested performances.
3. Glazed aluminum entrance doors.
4. Entrance door hardware specified in this Section.
5. Initial selection color samples.

C. Shop Drawings:

1. Plans and elevations for each installation.
2. Details of anchorage and support.
3. Details for continuity of air and water barrier with adjacent construction.
4. Details of flashing and internal drainage.
5. Provisions for thermal expansion and deflection.
6. Details of trim.
7. Details of extruded sills.
8. Sizes and locations of loads transmitted to building structural supports.

D. Schedules: Door hardware coordinated with hardware specified in Section 08 71 00.

E. Samples:

1. Typical Framing Member: 12 inches long in required finish.
2. Door: 12- by 12-inch bottom door corner showing construction, reinforcement, glazing, and weatherstripping.

1.4 INFORMATIONAL SUBMITTALS

A. Delegated Design Submittals: Design calculations.

B. Installer Qualifications: Specialized firm trained by and acceptable to system manufacturer.

C. Field Quality Control Submittals: Field test and inspection reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For framing system, doors, hardware, finishes.

B. Warranty Documentation: For storefront system and finishes.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Licensed Professionals: Registered in state in which Project is located.

B. Field Samples: Construct <sample description; sample size>, minimum size.

1. Photograph installation of sill flashing with end dams and other concealed components. Provide access to record photographs when requested by Architect.
2. Field samples are subject to Field Quality Control testing to verify performance.
3. Approved samples may remain as part of Work.
4. Approved samples establish work results standard.

C. Mockups: Demonstrate product assembly, intersections, and terminations.

1. Build mockup of typical wall area as shown on Drawings.
2. Mockups are subject to Field Quality Control testing to verify performance.
3. Photograph installation of sill flashing with end dams and other concealed components. Provide access to record photographs when requested by Architect.
4. Approved mockups establish work results comparison standard.
5. Remove mockups when acceptable to Architect.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store aluminum components elevated above grade, protected from precipitation and stormwater runoff.
2. Protect aluminum components from bending and from impact, abrasion, and other harmful contacts.
3. Maintain factory applied finish protections intact until time removal is recommended by manufacturer.

1.8 FIELD CONDITIONS

A. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

1.9 WARRANTY

A. Manufacturer Warranty: Repair or replace components that do not comply with requirements or that fail in materials or workmanship.

1. Failures under design conditions specified in performance requirements.

a. Breakage or loss of glass
b. Permanent deformation of components or assemblies.
c. Water penetration through fixed glazing.
d. Failure of hardware specified in this Section.

2. Warranty Period: Five years.

B. Finish Warranty: Repair deteriorated finishes or replace components.

1. Deterioration includes the following:

a. Color Fading: More than 5 Hunter units per ASTM D2244.
b. Chalking: More than No. 8 rating per ASTM D4214.
c. Paint cracking, peeling or checking.

2. Warranty Period: 20 years.

PART 2 - PRODUCTS

2.1 ALUMINUM-FRAMED STOREFRONTS

A. Manufacturers and Products:

1. EFCO Corporation .
2. Kawneer .
3. Oldcastle BuildingEnvelope .
4. U.S. Aluminum .
5. YKK AP .

B. Description: Extruded aluminum framing system, reinforced to support loads.

C. Interior Storefront:

1. Construction: Nonthermal.
2. Glass Installation: 4-side captured, installed fromManufacturer standard.
3. Glazing Plane: Center.
4. Profile Dimensions: See Drawings.
5. Finish: Clear anodized.

D. Sills: Extruded aluminum, finished same as framing.

E. Formed Trim: Aluminum sheet, 0.060 inch minimum thickness, finished same as framing.

2.2 GLAZING

A. Glass: Specified in Section 08 80 00.

B. Glazing Gaskets:

1. Material: EPDM or other synthetic rubber; PVC not permitted.
2. Color: Black.

C. Structural Silicone Glazing Sealant: Manufactured specifically for structural adhesion of glass; ASTM C1184; standard color selected by Architect.

1. DowDOWSIL 995.
2. GE Momentive UltraGlaze SSG4000.
3. Tremco Proglaze SSG.

D. Weatherseal Sealant: Specified in Section 07 92 00.

2.3 GLAZED ALUMINUM DOORS AND HARDWARE

A. Doors: Provide internal reinforcement needed for hardware.

1. Thickness: 1-3/4 inch.
2. Stiles: See Drawings.
3. Bottom Rail: ADA-compliant.
4. Exterior Doors: Thermally broken, prepared for 1-inch insulating glass.
5. Interior Doors: Prepared for 1- inch glass.
6. Glazing Beads: Architect selected profile.
7. Manufacturer Name Plates: Acceptable on door edges only.

B. Hardware: See Section 08 71 00 for items not specified in this Section.

C. Continuous-Gear Hinges: Manufacturer's standard with stainless-steel bearings between knuckles; fabricated to full height of door and frame.

1. Finish hinges to match door finish.

2. Manufacturers:

    a. Hager Companies.
    b. McKinney Products Company.
    c. Select Products Limited.

D. Thresholds: Extruded aluminum in ADA-compliant profile; BHMA A156.21.

E. Push and Pull Handles: Architect selected.

1. Pull Handle Length: 12 inches and Architect Selected.unless otherwise indicated.

F. Closers: ADA-compliant adjustable units for door size and anticipated use frequency; integral cushion stop that limits door swing to 110 degrees.

1. Surface-Mounted Closers: Aluminum case finished to match framing and doors; BHMA A156.4, Grade 1.
2. Concealed Overhead Closers: BHMA A156.8, Grade 1.
3. Manufacturers:

    a. Corbin Russwin Architectural Hardware.
    b. LCN Closers.
    c. Norton Door Controls.
    d. Rixson Specialty Door Controls.

G. Weatherstripping: Manufacturer’s standard replaceable type that meets performance requirements.

H. Interior Door Silencers: Manufacturer’s standard replaceable resilient type.

I. Removable Mullions: Extruded aluminum finished same as framing; BHMA A156.3.

2.4 PERFORMANCE

A. Structural Design Criteria: See Structural Drawings.

B. Structural Loads: Applicable code compliant.

1. Include loads from window cleaning and maintenance equipment:

C. Deflection: At design wind speed.

1. Perpendicular to Wall: 1/180 of span, not to exceed 3/4 inch edge of glass deflection.
2. Parallel to Glass Plane: 1/360 of span, not to exceed 1/8 inch.

D. Seismic Movement: Design to criteria stated on Structural Drawings.

E. Wind Movement: Design to criteria stated on Structural Drawings.

F. Structural Movement: Design to criteria stated on Structural Drawings.

G. Wind-Borne Debris Resistance:

1. ASTM E1886 missile impact and cyclic-pressure for Wind Zone 1.
2. Florida Non-High Velocity Hurricane Zone product approval.
3. Miami-Dade County High Velocity Hurricane Zone product approval.

H. Environmental Performance:

1. Air Infiltration: ASTM E238.

   a. Fixed Framing and Glass: <value> cfm/sq. ft., maximum at 1.57 lbf/sq.ft. static air pressure differential.
   b. Single Doors: <value> cfm/sq. ft., maximum at 1.57 lbf/sq.ft. static air pressure differential.

2. Thermal Transmission: NFRC 100; <Value> U-Value, maximum.
3. Condensation Resistance: NFRC 500, minimum 70 CRF.
4. Solar Heat Gain Coefficient: NFRC 200; 0.40, maximum.
5. Expansion and Contraction: Withstand thermal cycling over 120 degrees F ambient temperature and 180 degrees F on material surfaces.

I. Accessibility Requirements: Comply with applicable provisions in Department of Justice publication 2010 ADA Standards for Accessible Design, ICC/ANSI A117.1, and state accessibility code.

2.5 MATERIALS

A. Aluminum: Manufacturer's recommended alloy and temper.

1. Extruded Profiles: ASTM B221.
2. Sheet and Plate: ASTM B209.
3. Structural Items: ASTM B308.

B. Steel Reinforcement: Manufacturer's recommended coating to prevent galvanic reaction with aluminum framing.

1. Structural Shapes: ASTM A36/A36M
2. Cold-Rolled Shapes: ASTM A1008/A1008M.
3. Hot-Rolled Shapes: ASTM A1011/A1011M

C. Assembly Sealants: Silicone.

D. Fasteners: Stainless steel.

1. Where exposed or semi-exposed, use countersunk flathead screws finished to match adjacent surface.

E. Separation Coating: Bituminous paint; SSPC-Paint 12.

F. Concrete Anchors: Group 1 stainless steel expansion anchors.

2.6 FABRICATION

A. Fabricate components for uniform 1/2 inch shim space at jambs and heads.

B. Fabricate joints flush, hairline, and weathertight.

C. Provide internal reinforcements needed for performance requirements.

D. Maintain thermal break of exterior assemblies.

E. Conceal fasteners and attachments from view.

F. Provide flat closure plates for open channel perimeter frame members.

G. Fabricate sheet metal components per SMACNA Architectural Sheet Metal Manual.

1. Fabricate trim and flashing in lengths to minimize number of joints.
2. Fabricate trim to uniform sizes and profiles with smooth, flat surfaces free of oil-canning or other distortion.
3. Fabricate trim for concealed anchorage where possible.

H. Prepare components in shop for door hardware installation.

I. Provide continuity of drainage for condensation and infiltrated water to system weeps.

J. Separation Coating: Apply bituminous paint to surfaces that will contact concrete, dissimilar metals, or preservative-treated wood, or provide other permanent isolation material.

K. Glazing Option: Framing and doors may be factory glazed before delivery to Project site.

L. Fabrication Tolerances:

1. Square: 1/8 inch maximum difference in diagonal measurements.
2. Corner, Face Offsets: 1/32 inch maximum.
3. Bow in Framing Members: 1/16 inch maximum.
4. Joints: Hairline at permanent connections, 1/32 inch maximum at removable glazing stops.

2.7 FINISHES

A. Anodized: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker, or AAMA 612 with electro-deposition organic seal.

1. Color: Clear.

B. Contractor Option: Interior surfaces may receive powder or acrylic coating that matches color of exterior finish.

C. Finish for replacement aluminum glazed door on existing frame: match existing frame finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not install damaged or substandard components, including items that have deficient finishes.

1. Corrections in field are subject to Architect's approval before installation.
2. Return components to factory for remanufacturing or refinishing, or provide new components to replace items that cannot be satisfactorily corrected in field.

B. Install assemblies plumb, level, square, and accurately aligned.

C. Anchor assemblies securely to structural elements.

D. Set sill members with two lines of continuous sealant per Section 07 92 00.

E. Remove debris, dirt, aluminum scraps, and other materials from glazing channels.

F. Doors: Install for smooth operation and weathertight fit.

1. Hardware: Mount with concealed fasteners.
2. Set thresholds in continuous bed of sealant or gasketing and fasten rigidly in place so they do not rock or cause noise when walked on.

G. Glass Installation: Section 08 80 00.

H. Tolerances:

1. Variance from plumb, plane, and level:1/8 inch in 10 feet and 1/4 inch in 40 feet, maximum.
2. Variance in Alignment Between Adjacent Units:1/16 inch, maximum, and1/8 inch if units are separated by a reveal.

3.2 STRUCTURAL SILICONE GLAZING

A. Clean bond surfaces. Prime per sealant manufacturer recommendations.

B. Mask adjacent surfaces to prevent misapplication.

C. Install structural sealant to form continuous, watertight seals.

D. When sealant has fully cured, remove temporary glass retainers and fill voids with sealant.

E. Install weatherseal sealant per Section 07 92 00 to produce weatherproof joints.

3.3 ADJUSTING

A. Adjust doors and door hardware for smooth operation and secure weathertight closure at exterior doors.

B. Adjust door closers per ADA requirements.

3.4 CLEANING

A. Remove protective material from factory finished aluminum surfaces.

B. Wash surfaces as recommended by storefront and sealant manufacturers.

C. Remove excess sealant.

END OF SECTION

SECTION 08 62 00

UNIT SKYLIGHTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results: Acrylic glazed unit skylight at canopy.

B. Principal Products

1. Skylight

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week minimum before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Standard construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. AAMA/WDMA/CSA 101/I.S.2/A440 performance grade.
3. Acrylic glazing panels.

B. Shop Drawings:

1. Plans, elevations, sections, details, and attachment to other work.
2. Locations and magnitude of vertical and horizontal loads applied to building structure.
3. Provisions for draining infiltrated and condensation water to exterior; weep locations.
4. Seal to air and water barrier membrane in supporting and adjacent walls.

C. Samples: Rafter tube, 12 inches long in required color.

1.4 INFORMATIONAL SUBMITTALS

A. Delegated Design Submittals: Design calculations.

B. Field Quality Control Submittals: Field inspection reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Warranty documentation.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Licensed Professionals: Registered in state in which Project is located.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store components elevated above grade, protected from precipitation and stormwater runoff.
2. Protect components from bending and from impact, abrasion, and other harmful contacts.
3. Maintain factory applied finish protections intact until time removal is recommended by manufacturer.

1.8 FIELD CONDITIONS

A. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

1.9 WARRANTY

A. Manufacturer Warranty: Repair or replace components that do not comply with requirements or that fail in materials or workmanship.

1. Failures under design conditions specified in performance requirements.

a. Breakage or loss of glass
b. Permanent deformation of components or assemblies.
c. Water penetration through fixed glazing.
d. Air infiltration in excess of rated performance.
e. Noise or vibration.

2. Warranty Period: Five years.

B. Finish Warranty: Repair deteriorated finishes or replace components.

1. Deterioration includes the following:

a. Color Fading: More than 5 Hunter units per ASTM D2244.
b. Chalking: More than No. 8 rating per ASTM D4214.

c. Paint cracking, peeling or checking.

2. Warranty Period: Five years.

PART 2 - PRODUCTS

2.1 SKYLIGHTS -GENERAL

A. System has been tested and labeled per AAMA/WDMA/CSA 101/I.S.2/A440.

B. Configuration: See Drawings.

C. Glazing Method: Gasket glazing.

D. System is self-supporting when anchored to support curbs.

E. System has integral guttering system to drain infiltrated and condensation water to exterior.

F. System has gutters at bottom of glass that weep to exterior through baffled weep holes.

G. System has thermal barrier between exterior and interior frame components.

H. System has physical and thermal isolation of glazing from framing members.

2.2 SKYLIGHTS

A. Unit Skylights: Acrylic glazed assemblies.

1. Manufacturers:

a. Dalyte; Summit Series as basis of design.
b. Wasco.
c. Extech/Exterior Technologies, Inc.
d. Oldcastle BuildingEnvelope.
e. Super Sky Products.

B. Finish: Color coating.

C. Acrylic Glazing: ASTM D 4802, thermoformable, monolithic sheet, category as standard with manufacturer, Finish 1 (smooth or polished), Type UVF (formulated with UV absorber).

1. Double-Glazing Profile: Dome, 25 percent rise.

a. Thicknesses: As indicated.
b. Outer Glazing Color: Colorless, transparent.
c. Inner Glazing Color: Colorless, transparent.

2. Self-Ignition Temperature: 650 deg F (343 deg C) or more for plastic sheets in thickness indicated when tested according to ASTM D 1929.

3. Smoke-Production Characteristics: Smoke-developed index of 450 or less when tested according to ASTM E 84, and smoke density of 75 or less when tested according to ASTM D 2843
4. Burning Characteristics: Tested according to ASTM D 635. Class CC2, burning rate of 2-1/2 inches (64 mm) per minute or less for nominal thickness of 0.060 inch (1.5 mm) or thickness indicated foruse.

D. Exposed Flashing and Trim: Aluminum sheet, minimum 0.060 inch thickness; same finish as framing.

2.3 PERFORMANCE

A. Delegate skylight design to manufacturer's licensed Professional Engineer.

B. Structural Design Criteria: See Design Criteria: See Structural Drawings.

C. Seismic Movement: See seismic criteria on Structural Drawings.

1. Sway
2. Interstory Drift

D. Allowable Deflection: Maximum 1/180 span of glazing support members.

E. Wind-Borne Debris Resistance:

1. ASTM E1886 missile impact and cyclic-pressure for Wind Zone 1.

F. Exterior Fire Test Exposure: ASTM E108 or UL 790 testing by a qualified testing agency, Class A.

2.4 MATERIALS

A. Aluminum: Manufacturer's recommended alloy and temper.

1. Extruded Profiles: ASTM B221.
2. Sheet and Plate: ASTM B209.
3. Structural Items: ASTM B308.

B. Steel Reinforcement: Manufacturer's recommended coating to prevent galvanic reaction with aluminum framing.

1. Structural Shapes: ASTM A36/A36M
2. Cold-Rolled Shapes: ASTM A1008/A1008M.
3. Hot-Rolled Shapes: ASTM A1011/A1011M

C. Concealed Flashing: Dead soft stainless steel, 0.150 inch minimum thickness.

D. Assembly Sealant: Silicone.

E. Fasteners: Stainless steel.

1. Where exposed or semi-exposed, use countersunk flathead screws finished to match adjacent surface.

F. Separation Coating: Bituminous paint; SSPC-Paint 12.

2.5 FABRICATION

A. Rigidly fit and secure joints and corners, with connections that are flush, hairline, and weatherproof.

B. Fabricate components to allow for expansion and contraction with minimum clearance and shim spacing around perimeter of assembly.

C. Maintain continuous air and vapor barrier throughout assembly, with barrier plane aligned with inside pane of glazing continuing to glazing sealant heel bead.

D. Prepare components to receive anchorage devices. Ensure that fasteners and anchorage devices will be concealed upon completion of installation.

2.6 FINISHES

A. Anodizing: AAMA 611 Class I or AAMA 612 with electro-deposition organic seal.

1. Color: See Drawings.

B. Color Coating: Two-coat PVDF finish with minimum 50 percent Kynar 500 resin by weight in color; AAMA 2604.

1. Color: See Drawings.

C. Powder Coating: Thermoset polyester; AAMA 2603 but 1.5 mil minimum thickness.

1. Color:.

D. Contractor Option: Interior surfaces may receive powder or acrylic coating that matches color of exterior finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that structural curb is ready to receive skylight system.

B. Verify that adjacent air and water barrier membrane is installed.

3.2 PREPARATION

A. Apply protective coating to concealed aluminum and steel surfaces in contact with dissimilar materials.

3.3 INSTALLATION - Skylight framing

A. Install skylights plumb, level, accurately aligned, and free of warp or twist.

B. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.

C. Rigidly secure nonmovement joints.

D. Anchor skylights rigidly and securely to building structure.

E. Install flashing in longest lengths practical. Lap joints 6 inches and fill joint with full coating of non-migrating, non-hardening sealant. Secure flashings with concealed fasteners that allow thermal movement without buckling, loosening, loss of watertightness, or other damage.

F. Seal joints between members where needed to contain or direct water.

G. Verify that weeps and internal drainage systems are in place, unblocked, and fully functional before installing glass.

H. Clean glazing channels of debris, waste, aluminum scraps, and other loose or contaminating materials.

I. Fill shim spaces with mineral fiber insulation.

3.4 erection tolerances

A. Variation from Plumb, Level, or Line: 1/8 inch per 10 feet, or 3/8 inch total in overall dimension, maximum.

B. Alignment of Two Adjoining Members Abutting in Plane: Within 1/16 inch.

3.5 FIELD QUALITY CONTROL

A. Field Tests and Inspections: Owner will engage inspectors to perform tests and special inspections and to prepare reports. Allow inspectors access to work areas.

1. Retesting of Failed Tests: Performed at Contractor's expense.
2. Do not begin construction until inspectors have verified compliance of materials.
3. Do not use materials that fail tests and inspections.

B. Water-Spray Test: Before installation of finishes below skylight has begun, test skylights per AAMA 501.2. Verify no evidence water penetration.

C. Non-Conforming Work: Remove and replace, and re-test at Contractor’s expense.

3.6 CLEANING

A. Clean exposed surfaces. Remove excess sealants, and glazing materials.

B. Waste Management:

3.7 PROTECTION

A. Protect skylights from contaminating substances and glass damage.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

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. Mechanical door hardware for the following:

a. Swinging doors.

2. Cylinders for door hardware specified in other Sections.
3. Electrified door hardware.

B. Related Sections:

1. Section 081113 "Hollow Metal Doors and Frames" for door silencers provided as part of hollow-metal frames.
2. Section 081216 "Aluminum Frames" for door silencers provided as part of aluminum frames.
3. Section 081416 "Flush Wood Doors" for astragals and integral intumescent seals provided as part of labeled fire-rated assemblies.
4. Section 084113 "Aluminum-Framed Entrances and Storefronts" for installation of entrance door hardware, except cylinders.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Schedules shall be kept current with all changes to the project. If changes occur, project hardware schedules shall be maintained to reflect the changes as they are approved. Omitted items shall be deleted from openings, added and replaced items shall be included. Installation submittals shall be kept current as changes occur. Upon request, a complete updated hardware schedule shall be provided to the contractor. Supplemental submittals that include only the changed openings will not be acceptable.

C. Prior to final payment, provide a record copy of hardware schedules, including all revisions and updates. All openings shall be listed to reflect final installed configuration only.

D. Shop Drawings: Details of electrified door hardware, indicating the following:

1. Wiring Diagrams: For power, signal, and control wiring and including the following:

a. Details of interface of electrified door hardware and building safety and security systems.
b. Schematic diagram of systems that interface with electrified door hardware.
c. Point-to-point wiring.
d. Risers.
e. Elevations doors controlled by electrified door hardware.

2. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

E. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a. 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 the fabrication of other work that is critical in Project construction schedule.
b. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
c. Format: Use same scheduling sequence and format as in the Contract Documents.
d. Content: Include the following information:

1) Identification number, location, hand, fire rating, size, and material of each door and frame.
2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
5) Fastenings and other pertinent information.
6) Explanation of abbreviations, symbols, and codes contained in schedule.
7) Mounting locations for door hardware.
8) List of related door devices specified in other Sections for each door and frame.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Architectural Hardware Consultant.

B. Product Certificates: For electrified door hardware, from the manufacturer.

1. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

C. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

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.

B. Hardware Supplier Qualifications: The hardware supplier must be a corporate member in good standing of The Door and Hardware Institute (DHI), employing at least one Architectural Hardware Consultant (AHC) who is currently participating in DHI's continuing education program (CEP).

C. Architectural Hardware Consultant Qualifications: A 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 who is currently certified by DHI as follows:

1. For door hardware, an Architectural Hardware Consultant (AHC).

D. Source Limitations: Obtain each type of door hardware from a single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

E. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies 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 according to NFPA 252 or UL 10C, unless otherwise indicated.

F. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at the tested pressure differential of 0.3-inch wg (75 Pa) of water.

G. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

H. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

I. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC/ANSI A117.1 and IAC - Illinois Accessibility Code, latest version.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).
2. Comply with the following maximum opening-force requirements:

    a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
    b. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
    c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

J. Keying Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." In addition to Owner, Construction Manager, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant and Owner's security consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.
3. Requirements for key control system.
4. Requirements for access control.
5. Address for delivery of keys.

K. Preinstallation Conference: Conduct conference at Project site.

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.

L. Items of hardware not definitely specified herein but necessary for completion of the work shall be provided. Such items shall be of type and quality suitable to the service required and comparable to the adjacent hardware. Where size and shape of members is such as to prevent the use of types specified, hardware shall be furnished of suitable types having as nearly as practicable the same operation and quality as the type specified. Sizes shall be adequate for the service required.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

D. Deliver keys to Owner by registered mail or overnight package service.

1.8 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 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 hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.9 WARRANTY

A. Special 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. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of doors and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

a. Exit Devices: Two years from date of Substantial Completion.
b. Manual Closers: Ten years from date of Substantial Completion.

B. Factory direct order number shall be provided for each shipment of locks, closers and exit devices with warranty, prior to final payment.

1.10 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Provide parts and supplies that are the same as those used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.
2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality, and function.

2.2 HINGES

A. Hinges: BHMA A156.1.

1. Hinge Base Metal: Unless otherwise indicated, provide the following:
   a. Exterior Hinges: Stainless steel, with stainless steel pin.
   b. Interior Hinges: Steel, with steel pin.
2. Number of Hinges:
   a. Provide not less than 3 hinges per door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height.
3. Size of Hinges
   a. Provide standard weight (.134" thick) 4-1/2" x 4-1/2" ball bearing hinges on all doors up to and including 3'-0" in width. Over 3'-0" in width provide extra heavy weight ball bearing hinges (.180" thick) 4-1/2" x 4-1/2".
   b. Provide standard weight, 3-1/2" x 3-1/2" plain bearing hinges on all 1 3/8" thick wood doors.
4. Hinge options:
   a. Provide non removable pins at exterior openings and outswinging interior doors.
   b. All hinges shall be flat button tipped hinges
5. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hager Companies.
   b. Stanley.
   c. McKinney.
   d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.3 CONTINUOUS HINGES

A. Continuous Hinges: BHMA A156.26; minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hager Companies
   b. Pemko.
   c. Select Products Limited.
   d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.4 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch (13 mm) latchbolt throw.

C. Lock Backset: 2-3/4 inches (70 mm), unless otherwise indicated.

D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim and aluminum frames.
3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

E. Bored Locks: BHMA A156.2; Series 4000; Grade 2. Mortise locks BHMA A156.13; Series 1000 at unit entry applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Yale – 5300LN Series.
b. No alternate manufacturers will be accepted without architect’s approval prior to bidding.

2.5 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch (19-mm) throw; designed for mortising into door edge.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Rockwood Manufacturing.
b. Hager Companies.
c. Ives.
d. No alternate manufacturers will be accepted without architect’s approval prior to bidding.

2.6 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

A. Automatic and Self-Latching Flush Bolts: BHMA A156.16; minimum 3/4-inch (19-mm) throw; designed for mortising into dooredge.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Rockwood Manufacturing.
b. Hager Companies.
c. Ives.
d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.7 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Yale.
b. Sargent.
c. Precision.
d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.8 LOCK CYLINDERS

A. Lock Cylinders: BHMA A156.5, Grade 1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Yale.
b. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.9 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

1. Master Key System: Provide cylinders to operate within existing Yale key system.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: "DO NOT DUPLICATE."

2. Quantity: In addition to one extra key blank for each lock, provide the following:

a. Change Keys: Three.
b. Master Keys: Five.

2.10 OPERATING TRIM

A. Operating Trim: BHMA A156.6; stainless steel, unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hager Companies.
b. Rockwood Manufacturing Company.
c. Trimco.
d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.11 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.

B. Astragals: BHMA A156.22.

2.12 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Norton.
b. LCN.
c. Yale.

2.13 LOW ENERGY AUTOMATIC DOOR OPERATORS

A. Automatic Operators: BHMA A156.19. Furnish all material and equipment necessary for the proper installation of low entry power operated door system.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Horton.
    b. Stanley – Magic Force.

2.14 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Rockwood Manufacturing Company.
    b. Hager Companies.
    c. Ives.
    d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.15 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: BHMA A156.8.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Glynn-Johnson.
    b. Rixson.
    c. Architectural Builders Hardware.
    d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.16 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Hager Companies.
    b. National Guard Products.
    c. Pemko Manufacturing Co.
    d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.17 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hager Companies.
b. National Guard Products.
c. Pemko Manufacturing Co.
d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.18 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- (1.3-mm-) thick stainless steel with countersunk screw holes and 4 beveled edges; with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Rockwood Manufacturing Company.
b. Hager Companies.
c. Trimco.
d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.19 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Rockwood Manufacturing Company.
b. Hager Companies.
c. Trimco.
d. No alternate manufacturers will be accepted without architect's approval prior to bidding.

2.20 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Fire-Rated Applications:

    a. Wood or Machine Screws: For the following:

        1) Hinges mortised to doors or frames**;** use threaded-to-the-head wood screws for wood doors and frames.
        2) Strike plates to frames.
        3) Closers to doors and frames.

    b. Steel Through Bolts: For the following unless door blocking is provided:

        1) Surface hinges to doors.
        2) Closers to doors and frames.
        3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."
5. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.21 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other 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 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. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

B. Wood Doors: Comply with DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."

3.3 INSTALLATION

A. Mounting Heights: 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 door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number 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.

D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot

per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).

E. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.

1. Configuration: Provide one power supply for each door opening with electrified door hardware.

F. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

G. 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 will impede traffic.

H. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

I. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

J. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant 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.

3.5 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. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 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 that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Section 017900 "Demonstration and Training."

B. DOOR HARDWARE SCHEDULE

SET 01

EA	HINGES	AS SPECIFIED ABOVE	633	MCK
1 EA	STOREROOM LOCK	AU 5305LN	606	YAL
1 EA	OVERHEAD STOP	1-SERIES	606	RIX

SET 02

EA	HINGES	AS SPECIFIED ABOVE	633	MCK
1 EA	ENTRANCE LOCK	AU 5304LN	606	YAL
1 EA	CLOSER	8501	696	NOR
1 EA	WALL STOP	409	606	ROC

SET 03

EA	HINGES	AS SPECIFIED ABOVE	633	MCK
1 EA	STOREROOM LOCK	AU 5305LN	606	YAL
2 EA	CLOSER	CPS 8501	696	NOR
1 SET	AUTO FLUSH BOLT	2842	606	ROC
1 EA	COORDINATOR	2672 x Mtg Brkts	606	ROC

SET 04

EA	HINGES	AS SPECIFIED ABOVE	633	MCK
1 EA	RIM EXIT DEVICE	7100F x AU627F-KNURLED	606	YAL
1 EA	CYLINDER	AS REQUIRED	606	YAL
1 EA	CLOSER	CPS 8501	696	NOR

SET 05

EA	HINGES	AS SPECIFIED ABOVE	606	MCK
1 EA	STOREROOM LOCK	AU 5305LN	606	YAL
2 EA	FLUSH BOLT	555	606	ROC
2 EA	OVERHEAD STOP	1-SERIES	606	RIX
1 SET	SEAL	160	DKB	NGP
2 EA	SWEEP	200N	DKB	NGP
1 EA	THRESHOLD	425	AL	NGP
1 EA	RAIN DRIP	16	DKB	NGP

SET 06

1 EA RIM EXIT DEVICE	7100F x 626F	606	YAL
1 EA CYLINDER	AS REQUIRED	606	YAL

-REMAINDER OF HARDWARE BY PARTITION MANUFACTURER.

SET 07

2 EA	CONTINUOUS HINGE	SL12HD	CLR	SEL
1 EA	RIM EXIT DEVICE	7100F x 621F	630	YAL
1 EA	RIM EXIT DEVICE	7100F	630	YAL
1 EA	CYLINDER	AS REQUIRED	626	YAL
2 EA	OFFSET PULL	BF158	630	ROC
1 EA	ADA OPERATOR	S4100LE	CLR	HOR
2 EA	ACTUATOR	BY HANDICAP OPERATOR		
1 EA	CLOSER	7500 x DP x BSS	689	NOR
2 EA	OVERHEAD STOP	1-SERIES	630	RIX
2 EA	ELECTRIC STRIKE	9600	630	HES
2 EA	SWEEP	200N	AL	NGP
2 EA	THRESHOLD	425	AL	NGP
1 EA	CARD READER	BY SECURITY CONTRACTOR		

-Doors normally closed and locked. Presenting credential will open electric strikes and allow doors to be manually, or automatically, opened. Doors will remain secure upon loss of power. Free egress allowed at all times by panic device.
-Seals and mullion by door manufacturer.

SET 08

2 EA	CONTINUOUS HINGE	SL12HD	CLR	SEL
2 EA	PUSH-PULL BAR	BF15847	630	ROC
1 EA	ADA OPERATOR	S4100LE	CLR	HOR
2 EA	ACTUATOR	BY HANDICAP OPERATOR		
1 EA	CLOSER	7500 x DP x BSS	689	NOR
2 EA	OVERHEAD STOP	1-SERIES	630	RIX
2 EA	SWEEP	200N	AL	NGP
2 EA	THRESHOLD	425	AL	NGP

-Doors normally closed and locked. Presenting credential will open electric strikes and allow doors to be manually, or automatically, opened. Doors will remain secure upon loss of power. Free egress allowed at all times by panic device.
-Seals and mullion by door manufacturer.

SET 09

1 EA	CONTINUOUS HINGE	SL12HD	CLR	SEL
1 EA	RIM EXIT DEVICE	7100 x 621F	630	YAL
1 EA	CYLINDER	AS REQUIRED	626	YAL
1 EA	OFFSET PULL	BF158	630	ROC
1 EA	ADA OPERATOR	S4100LE	CLR	HOR
2 EA	ACTUATOR	BY HANDICAP OPERATOR		
1 EA	CLOSER	7500 x DP x BSS	689	NOR
1 EA	OVERHEAD STOP	1-SERIES	630	RIX
1 EA	ELECTRIC STRIKE	9600	630	HES
1 EA	SWEEP	200N	AL	NGP
1 EA	THRESHOLD	425	AL	NGP

1 EA CARD READER BY SECURITY CONTRACTOR
-Door normally closed and locked. Presenting credential will open electric strike and allow door to be manually, or automatically, opened. Door will remain secure upon loss of power. Free egress allowed at all times by panic device.
-Seals by door manufacturer.

SET 10

1 EA	CONTINUOUS HINGE	SL12HD	CLR	SEL
1 EA	PASSAGE SET	AU 5301LN	626	YAL
1 EA	CLOSER	8501 x DP x BSS	689	NOR
1 EA	OVERHEAD STOP	1-SERIES	630	RIX

-Seals by door manufacturer.

SET 11

1 EA	CONTINUOUS HINGE	SL12HD	CLR	SEL
1 EA	RIM EXIT DEVICE	7100 x 628F	630	YAL
1 EA	CLOSER	7500 x DP x BSS	689	NOR
1 EA	OVERHEAD STOP	1-SERIES	630	RIX
1 EA	SWEEP	200N	AL	NGP
1 EA	THRESHOLD	425	AL	NGP

-Seals by door manufacturer.

END OF SECTION 087100

SECTION 08 80 00

GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Insulating glass unit for interior storefronts
2. Insulating glass unit for replacement storefront glass door.
3. Clear tempered glass for borrowed lites.
4. Glazing film on borrowed lites.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting at project site in conjunction with preinstallation meetings for fenestration framing systems.
2. Agenda Items:

    a. Coordinate schedules and material deliveries.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Each type of glass.
2. Initial selection color charts:

    a. Interlayer for laminated glass.

B. Samples: 12- by 12-inch samples of each glass type except clear monolithic.

1.4 CLOSEOUT SUBMITTALS

A. Warranty Documentation: For insulating glass.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: NACC certified contractor, AGMT certified glazing technicians, or certified under National Glass Association's Certified Glass Installer Program.

1.6 FIELD CONDITIONS

A. Ambient Conditions:

1. Temperature: Minimum 40 degrees F and rising.
2. Install glass only on when glazing frames are free of moisture, including condensation, frost, and ice.

1.7 WARRANTY

A. Insulating Glass: Manufacturer warranty for replacement of insulating glass units with failure of edge seal, internal condensation that does not dissipate, inner and outer panes in contact, spacer delamination, or other defects.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BASE GLASS

A. Clear Glass: ASTM C1036, Type I, Class 1, Quality-Q3.

B. Low-Iron (Ultra-Clear) Glass: ASTM C1036, Type I, Class 1, Quality q3; minimum 90 percent visible light transmission.

1. Guardian UltraClear.
2. Pilkington Optiwhite
3. Vitro Acuity.

C. Manufacturer:

1. Oldcastle BuildingEnvelope
2. Guardian Glass
3. Pilkington North America
4. Vitro Architectural Glass

2.2 COATED GLASS

A. Vacuum Deposition Coated Glass: ASTM C1376.

1. Insulating Glass: Delete or omit coating from glass edges where spacer sealant is applied.
2. Color and Performance Attributes: See glass schedule.

B. Pyrolytic Coated Glass:

1. Insulating Glass: Delete or omit coating from glass edges where spacer sealant is applied.
2. Color and Performance Attributes: See glass schedule.

C. Silk-Screened Glass: Ceramic enamel patterns applied by silk-screen process to glass.

1. Base Glass: Clear.
2. Color: Architect selected.
3. Pattern: See Drawings
4. Location: See Drawings

2.3 INSULATING GLASS

A. Insulating Glass Units (IGU): Factory assembled double-pane units tested per ASTM E2190 .

B. Spacer Strips: Stainless steel with desiccant fill.

C. Space Fill: Dehydrated argon.

D. Edge Seals:

1. Primary Seal: Polyisobutylene.
2. Secondary Seal: Silicone.
3. IGU for Structural Silicone Glazing: Edge seals Tested for compatibility with proprietary brand of silicone glazing sealant used on Project.

2.4 insulating glass to match existing

A. Insulating Glass Units (IGU): match existing storefront glass.

2.5 glazing film

A. Manufacturers and Products

1. Basis of Design Product: See Finish Schedule on Drawings.

B. Film Type: Manufacturer's standard polyester film with pressure-sensitive, clear adhesive back for adhering to glass and releasable protective backing.

C. Style, Thickness, and Color: Architect selected.

2.6 INSTALLATION MATERIALS

A. Setting Blocks: ASTM C864, neoprene or EPDM, or ASTM C1115, silicone; 80 to 90 Shore A durometer hardness.

B. Spacers: ASTM C864, neoprene or EPDM, or ASTM C1115, silicone; 50 to 60 Shore A durometer hardness.

C. Structural Silicone Sealant: Specified with framing system.

D. Glazing Gaskets: Specified with framing system.

E. Butt Joint Glazing Sealant: Medium modulus silicone sealant; single-component, neutral-curing; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Color: .
2. Products:

a. Dow Corning Corporation Dowsil 795.
b. GE Construction Sealants SCS2000 SilPruf.
c. Pecora Corporation PCS.
d. Sika Corporation Sikasil WS-295
e. Tremco Spectrem 2.

F. Interior Glazing Tape: ASTM C1281 and AAMA 800; butyl based elastomeric tape with integral resilient tube spacer, 10 to 15 Shore A durometer hardness, black color, coiled on release paper; widths required for installation.

1. Supply preshimmed tape with continuous spacer for hollow metal and wood glazing frames and elsewhere as recommended by tape manufacturer.

G. Exterior Glazing Tape: AAMA 800; closed cell polyvinyl chloride foam, maximum 2 percent water absorption by volume, designed for 25 percent compression percent for air barrier and vapor retarder seal, black color, coiled on release paper over adhesive on two sides; widths required for installation.

H. Smoke Removal Targets: As required by local fire marshal.

2.7 PERFORMANCE DESIGN CRITERIA

A. Structural Design Criteria: See Structural Drawings.

B. Structural Loads: See Drawings.

1. Wind Load:
2. Snow Load:

C. Wind-Borne Debris Resistance:

1. ASTM E 1886 missile impact and cyclic-pressure for Wind Zone 1.

D. Impact:

1. Safety Glazing: Provide tempered or laminated glass conforming to 16 CFR 1201, Category II.

2.8 FABRICATION

A. Perform all fabrication before delivering glass to site.

B. Provide permanent labels required by regulations in locations that will be visible after installation.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Framing is ready to receive glazing.
2. Weep systems are unblocked and functional.
3. Face and edge clearances are sufficient.
4. Framing joints are properly sealed.

B. Examine glass lites for damage and defects before installation.

C. Do not install tempered glass with noticeable roller pick optical distortion.

3.2 PREPARATION

A. Clean glazing channels and rabbets; remove loose materials and moisture.

B. Remove protective coatings on metal surfaces.

C. Clean glass just before installation.

3.3 INSTALLATION - GENERAL

A. Install glass without direct contact on framing surfaces.

B. Maintain manufacturer's recommended edge and face clearances between glass and frame members.

C. Set glass centered in openings on setting blocks.

D. Provide edge blocking needed to prevent sideways movement of glass in framing.

E. Set glass with correct orientation of exterior side.

3.4 INSTALLATION - GASKET GLAZING

A. Fabricate gaskets to fit openings.

B. Install gaskets in single pieces on each side of opening with joints only at corners.

C. Where recommended by framing system manufacturer, seal corners watertight.

D. Compress gaskets to produce weathertight seal without causing bending stresses in glass.

3.5 CLEANING

A. Remove nonpermanent labels and clean surfaces after installation.

B. Clean glass on both sides shortly before inspection for Substantial Completion.

3.6 PROTECTION

A. Protect glass vulnerable to damage with streamers attached to framing.

B. Exterior Glass:

1. Examine glass surfaces below concrete or masonry for alkaline deposits and dirt, and remove such soiling when observed.
2. Provide new replacement units for damaged glass, including glass with stains or etching that cannot be removed.

END OF SECTION

SECTION 08 90 00

LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results:

1. Fixed, extruded-aluminum louvers.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

C. Delegated-Design Submittal: For louvers indicated to comply with structural performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.3 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.4 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver:

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. Industrial louvers, Inc.
b. Ruskin Company; Tomkins PLC.
c. Airolite Company, LLC (The).
d. Construction Specialties, Inc.
e. Greenheck Fan Corporation.

2. Louver Depth: Not less than 6 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
4. Frame Nominal Thickness: Not less than 16 gage for blades and frames.

5. Blade Nominal Thickness: Not less than 20 gage for blades and frames.
6. Blade Angle: 45 degrees.
7. Louver Performance Ratings:

    a. Free Area: 7.91 sq. ft.
    b. Percent Free Area: 50.

8. Minimum Air Volume Flow Rate at Beginning Point of Water Penetration: 4,761 cfm.
9. Maximum Static Pressure at Beginning Point of Water Penetration: 0.08 in. H2O.
10. Aluminum: ASTM B221, 6063 alloy, T-5 temper; extruded shape.
11. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening.

B. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached.
2. Finish: Mill finish unless otherwise indicated.
3. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screening:

1. Bird Screen: Interwoven wire mesh of stainless steel, 3/4-inch square mesh wire.

2.5 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.

D. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For color-finished louvers, use fasteners with heads that match color of louvers.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.6 ACCESSORIES

A. Fasteners and Anchors: Stainless steel type.

B. Flashings:

1. Sheet Aluminum: ASTM B209, minimum 0.032 inch thick.

C. Sealants: Type specified in Division 07.

2.7 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Include supports, anchorages, and accessories required for complete assembly.

D. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.

1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.

E. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.8 ALUMINUM FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish louvers after assembly.

C. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and 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.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, 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 setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 09 05 61

COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results:

1. Prepare existing concrete slabs for the following flooring types:

   a. Resilient tile.
   b. Tile carpet.

2. Remove existing floor coverings.
3. Test concrete floor slabs for moisture and alkalinity (pH).
4. Remediate concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.

B. Principal Products:

1. Testing apparatus
2. Patching and self-leveling compounds
3. Remedial floor coatings.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate <work results of this Section> with <other work>.

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:

   a. Moisture and alkalinity (pH) limits and test methods.
   b. Manufacturer's required bond/compatibility test procedure.

2. Remedial Materials:

    a. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.

1.4 INFORMATIONAL SUBMITTALS

A. Visual Observation Report: For existing floor coverings to be removed.

B. 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. Include certification of accuracy by authorized official of testing agency.
7. Submit report to Architect not more than two business days after conclusion of testing.

C. Adhesive Bond and Compatibility Test Report.

D. Specimen Warranty: Issued by remedial material manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Warranty Documentation: For remedial floor coatings.

1.6 QUALITY ASSURANCE

A. Testing Agency: Employ and pay for an independent testing agency to perform moisture and alkalinity (pH) testing.

1. Qualifications: Experienced in specified testing methods.
2. Contractor's Responsibility Relating to Independent Agency Testing:

    a. Provide access for and cooperate with testing agency.
    b. Confirm date of start of testing at least 10 days before actual start.
    c. Allow at least 4 business days on site for testing agency activities.
    d. Achieve and maintain specified ambient conditions.
    e. Notify Owner when specified ambient conditions have been achieved and when testing will start.

B. Mockup: Construct and test mockup per ASTM F3010.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials in manufacturer’s packaging; include installation instructions.

B. Keep materials from freezing.

1.8 FIELD CONDITIONS

A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours before 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 before testing, at not less than 40 percent and not more than 60 percent.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Patching and Self-Leveling Compound:

1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being installed to thicknesses indicated and feathered to nothing at edges.
2. Compressive Strength: 4000 psi, minimum, after 28 days, per ASTM C109/C109M or ASTM C472, whichever is appropriate.

B. Alternate Flooring Adhesive: Floor covering or adhesive manufacturer's recommended product, suitable for the moisture and pH conditions present.

1. VOC Content: 50 g/L, maximum.

C. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination.

1. Manufacturers and Products: Recommended by testing agency or one of the following:

a. ARDEX Engineered Cements; ARDEX MC ULTRA with ARDEX FEATHERFINISH.
b. Dependable Floor Products; VAPORSEAL-HM with Dependable SKIMFLOW ES.
c. Koster American Corporation; Koster VAP I 2000 with Koster SL Premium overlay.
d. LATICRETE International, Inc; LATICRETE SUPERCAP Moisture Vapor Control with LATICRETE SUPERCAP Underlayment.
e. Mapei Planiseal VS with Mapei PlaniLevel 560.
f. UZIN, a division of UFLOOR Systems Inc; UZIN PE 460 with UZIN PE 280 and UZIN NC 150.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Follow ASTM F3010.

3.2 CONCRETE SLAB PREPARATION

A. Follow recommendations of testing agency and ASTM F3010.

B. Perform following operations in the order indicated:

1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:

    a. Observe existing floor covering for adhesion, water damage, alkaline deposits, and other defects.
    b. Remove existing floor covering.

2. Existing concrete slabs with coatings or penetrating sealers/hardeners/dustproofers:

    a. Do not attempt to remove coating or penetrating material.
    b. Do not abrade surface.

3. Perform preliminary cleaning.
4. Internal Relative Humidity Testing: 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise required by flooring manufacturer.
5. Alkalinity (pH) Tests: Perform in same locations as relative humidity tests.
6. Specified remediation, if required due to relative humidity test result.
7. Patching, smoothing, and leveling.
8. Other preparation specified in finish flooring sections.
9. Adhesive bond and compatibility test.
10. Protection.

C. Remediations:

1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct before doing any other remediation; re-test after correction.
2. Excessive 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):

    a. If remedial floor coating is necessary to address excessive moisture, no additional remediation is required for pH.
    b. If an adhesive that is resistant to the pH 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.

3.3 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.

3.4 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 for cleaning.

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. Test in accordance with ASTM F2170 Procedure A. Calcium Chloride and electrical impedance or resistance testing may not be substituted for the specified ASTM test method.

C. In the event that test values exceed floor covering manufacturer's limits, perform remediation. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

D. 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. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.

C. 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.

D. In the event that test values exceed floor covering manufacturer's limits, perform remediation. 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 recommendations of testing agency.

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. Mix and apply remedial floor coating.

1. Prohibit traffic during application.
2. Honor substrate control, isolation and expansion joints.
3. Prime substrate, and apply floor coating in layers as recommended by manufacturer.
4. Allow coating to cure before applying finish flooring.

3.10 PROTECTION

A. Cover prepared floors with building paper or other durable covering until finish flooring is installed.

END OF SECTION

SECTION 09 21 16.23

GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Fire reistance rated enclosures for horizontal shafts

B. Principal Products

1. Tested assemblies of steel studs with gypsum panels.

C. Related Requirements

1. Section 09 29 00: Room-side gypsum board, acoustical insulation and sealant.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Gypsum board shaft wall components.

1.3 INFORMATIONAL SUBMITTALS

A. ICC--ES Evaluation Reports:

1. Shaft wall assemblies

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:

1. Comply with manufacturer's recommendations and ASTM C 840.
2. Deliver products in manufacturer's undamaged packaging.
3. Obtain bill of lading. Verify delivery is complete and products are undamaged.

B. Storage and Handling Requirements:

1. Store products indoors, protected from elements.

1.5 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.
2. Do not install products that are wet, moisture damaged or mold damaged.

PART 2 - PRODUCTS

2.1 MANUFACTURERS [AND PRODUCTS]

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Fire-Resistance Rating: See Drawings.

B. STC Rating: See Drawings.

C. Studs:

1. Depth: See Drawings.
2. Minimum Base-Metal Thickness: .

D. Room-Side Finish: See Drawings.

E. Shaft-Side Finish: Gypsum shaftliner board, moisture- and mold-resistant Type X.

F. Insulation: Sound attenuation blankets.

2.3 GYPSUM SHAFTLINER PANELS

A. Gypsum Shaftliner Boards - General: Comply with ASTM C 1396.

B. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X:

1. Manufacturers and Products:

a. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
b. Continental Building Products; Weather Defense Shaftliner Type X.
c. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra 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.

2.4 PERFORMANCE

A. Delegate <Product or system> design to manufacturer's licensed Professional Engineer.

B. Structural Design Criteria: See Structural Drawings.

C. Sustained Air-Pressure Loads: 5 lbf/sq ft.

D. Allowable Maximum Deflection:

1. Exposed Gypsum Board: L/240.
2. Tile Finish: L/360.
3. Stone Facing: L/360.

E. Fire Resistance:

1. ASTM E119.

F. Acoustic Performance:

1. STC: Tested in accordance with ASTM E 90 and classified in accordance with ASTM E413 by a testing and inspecting agency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify substrates are ready and comply with installation tolerances for shaft wall assemblies, including slabs and structural framing.

B. Verify that elements in shafts have been fully observed and are ready to be enclosed.

C. Examine panels for moisture and mold; discard damaged panels.

3.2 PREPARATION

A. Remove sprayed fireproofing to the extent required to install gypsum shaft wall assemblies. Patch damaged fireproofing.

3.3 INSTALLATION

A. Comply with fire-resistance-rated assembly design and ASTM C754.

B. Independently frame either side of building control joints and expansion joints; do not cross joints with framing members.

C. Install backing whereshown and where needed for fixtures, equipment, or other construction.

D. Acoustically-Rated Partitions: Comply with indicated sound-rated assembly requirements.

E. Shaft Wall Liner Panels: Cut panels to accurate dimension and install sequentially between studs.

3.4 ADJUSTING

A. Remove interior gypsum products exposed to water during construction period. Remove entire gypsum board panels; do not cut and patch gypsum board.

3.5 CLEANING

A. Remove spills, spatters, and misapplications of finishing materials as they occur.

B. Repair other finish surfaces damaged during drywall operations.

3.6 PROTECTION

A. Protect installed products from moisture and damage.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Interior studs and furring
2. Horizontal steel suspension systems for support of gypsum board assemblies.
3. Backing plates not provided by other trades for support of items attached to metal framing system.

1.2 ACTION SUBMITTALS

A. Product Data: Descriptive data for each item proposed for use.

1.3 INFORMATIONAL SUBMITTALS

A. ICC-ES Evaluation Reports:

1. Embossed high-strength steel studs.
2. Firestop tracks.
3. EQ coatings.

B. Delegated Design Submittals:

1. Non-structural metal framing, for deflection limits under horizontal loading. Indicate the following for each partition type and height:

a. Stud size.
b. Stud thickness.
c. Spacing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

A. Product Requirements: Specified in this Section.

2.2 PARTITION FRAMING

A. Framing Members and Components - General: AISI S220, sheet steel.

1. Protective Coating: ASTM A653/A653M, G40, hot-dip galvanized. EQ coatings conforming to AISI S220 that have ICC-ES Evaluation Reports are acceptable.

B. Studs and Tracks: At Contractor's option, use standard steel studs and tracks and high-strength embossed steel studs and tracks.

C. Standard Studs and Tracks:

1. Depth: See Drawings.
2. Thickness: 33 mils.

D. Deflection Top Track: Provide one of the following:

1. Single Long-Leg Track: Steel top track with 2-1/2 inch deep flanges; studs friction fit.
2. Single Slotted Track: Steel top track with 2-1/2 inch deep slotted flanges; studs fastened through slots.
3. Steel Thickness: Match studs.

E. Hat-Shaped Furring Channels:

1. Minimum Thickness: See Drawings.
2. Depth: See Drawings.

F. Z-Furring:

1. Minimum Thickness: 18 mils.
2. Depth: Sufficient to accommodate insulation.

G. Bridging: Cold-rolled steel channels, 54 mil thick, with minimum 1/2 inch wide flanges.

1. Depth: 1-1/2 inches.

2.3 BACKING

A. Backing Materials - General: At Contractor's option, use manufactured, preformed sheet steel backing and manufactured flexible wood backing system.

B. Manufactured, Preformed Sheet Steel Backing: 6 inch wide, 68 mil steel, formed to fit stud spacing.

1. Manufacturers and Products:

a. Perfect Wall, Inc. Flush-Mount Flat Reinforced Backing.

C. Wood Backing System: Fire-retardant treated wood and predrilled steel clips for fastening to steel studs.

1. Manufacturers and Products:

    a. ClarkDietrich Danback.
    b. Mantisgrip Mantisgrip Backing Clip.
    c. SCAFCO Kiwk-Back.

D. Flat Strap Backing Plates: Steel sheet screwed to studs.

1. Width: As needed for secure anchorage of wall-mounted items, but not less than 6 inches.
2. Thickness: 63 mils minimumwhere supporting the following items.

    a. Handrails, grab bars, and other items that support live loads.
    b. Curtains and drapery track.
    c. Wall-supported counter tops and cabinets.
    d. Ladders.
    e. Electrical panels.
    f. Electrically-operated fixtures, furnishings, or equipment.
    g. Large lighting fixtures.
    h. Wall mounted televisions and monitor screens.
    i. Mirrors.
    j. Large artwork.

3. Thickness: 33 mils minimumwhere supporting the following items.

    a. Wood trim.
    b. Toilet and bath accessories, other than grab bars.
    c. Small lighting fixtures.
    d. Anchorage for base cabinets.
    e. Small artwork.

2.4 FIRESTOPPING ACCESSORIES

A. Firestopping for Head of Wall Joints: Section 07 84 00.

B. Firestop Track:

1. Top track manufactured to accommodate structural deflection while maintaining fire-resistance-rated assembly continuity.

    a. Manufacturers and Products:

        1) CEMCO FAS-Track.
        2) ClarkDietrich BlazeFrame DL 2.
        3) Fire Trak Corp Fire Trak System.
        4) Metal-Lite The System.

2. Intumescent Firestop Seal: One-piece, pre-formed foam seal fitting over top tracks.

    a. Width: Accommodating track depth.
    b. Manufacturers and Products:

1) Hilti, Inc. Model CFS-TTS, Firestop Top Track Seal.

2.5 ACOUSTICAL ACCESSORIES

A. Resilient Furring Channels: Asymmetrical, 1/2 inch deep.

B. Acoustical Furring Clips: Molded rubber and galvanized steel mount clip used to attach furring and gypsum wallboard wall or floor/ceiling assemblies.

1. Manufacturers and Products:

a. PAC International RSIC-1.
b. Pliteq Inc. GenieClip.

C. Acoustical Sealant: Section 07 92 00.

2.6 SUSPENSION SYSTEMS

A. Anchorage Devices: Powder-actuated fasteners, fabricated with loops for attaching wire hangers.

B. Wire Hangers: ASTM A641, zinc coated, 0.16 inch minimum diameter.

C. Hanger Rods: Mild steel, 1/4 inch diameter, galvanized per ASTM A153.

D. Grid Suspension System: Direct-hung, pre-engineered ceiling suspension system.

1. Manufacturers and Products:

a. Armstrong Drywall Grid Systems.
b. Rockfon Chicago Metallic Drywall Grid.
c. USG Drywall Grid.

2.7 PERFORMANCE

A. Structural Design Criteria:

1. Horizontal Partition Load: 5 psf.
2. Vertical Ceiling Load: Supported material dead load.
3. Partition Horizontal Deflection Limits:

a. Tile and Stone Finished Partitions: 1/360 of wall height.
b. Other Partitions: 1/240 of wall height.

4. Ceiling Vertical Deflection Limits: 1/360 of span.

B. Fire Resistance:

1. Fire-Rated Assemblies: Materials and construction identical to those tested per ASTM E119 for rating shown.

C. Acoustic Performance:

1. STC-Rated Assemblies: Assemblies tested per ASTM E90 and classified per ASTM E413. See Drawings for STC ratings.

2.8 ACCESSORIES

A. Anchors: Types recommended by framing manufacturer for substrates.

B. Fasteners: ASTM C1002; Type S; length to suit application.

C. Tie Wire: ASTM A641, zinc coated, 0.062 inch diameter, minimum.

D. Acoustic Gaskets: Closed-cell foam self-adhesive strips that allow fastener penetration without foam displacement, minimum 1/8 inch thick, in widths to match stud sizes.

E. Isolation Strip at Exterior Walls:

1. Asphalt-Saturated Organic Felt: ASTM D226, Type I (#15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify rough-in utilities in are proper locations.

3.2 INSTALLATION - GENERAL

A. Installation Standard: Comply with ASTM C754.

B. Independently frame either side of building control joints and expansion joints; do not cross joints with framing members.

3.3 INSTALLATION - PARTITION FRAMING

A. Framing to Structure: Extend partition framing to underside of structure. Attach ceiling track to structure.

B. Framing to Ceiling: Extend framing to ceiling. Attach ceiling track to acoustic ceiling track in accordance with manufacturer's recommendations.

C. Brace stud framing system rigid; attach bridging to prevent stud rotation.

D. Orient stud flanges the same direction within wall assembly.

E. Stud Spacing: As required for performance requirements, but not more than 16 inches o/c.

F. Install backing where shown and where supporting wall-mounted fixtures, furniture, equipment, or other construction.

G. Fire-Resistance-Rated Partitions: Comply with tested assembly requirements.

1. Firestop Track: Install according to manufacturer's instructions.

H. Acoustically-Rated Partitions: Comply with indicated sound-rated assembly requirements.

I. Deflection Accommodation: Where framing extends to overhead structure, install deflection top track systems to prevent axial loading of finished assemblies.

J. Framed Openings:

1. Install two studs at each jamb unless otherwise indicated.
2. Headers: Install track on top of header for installation of cripple studs.

K. Direct Furring:

1. Anchor furring channels spaced 16 inches to substrate.

a. Exterior Walls: Provide foam gasket isolation strip between furring and exterior wall

L. Z-Furring:

1. Apply insulation as specified in Section 07 21 00. Hold insulation in place with z-furring members spaced at 24 inch centers, anchored to substrate.

3.4 INSTALLATION - SUSPENSION SYSTEMS

A. Suspension System Spacings:

1. Hangers: 48 inches.
2. Main Runners: 48 inches.
3. Furring Channels: 16 inches.

B. Isolate suspension systems from building structure and other objects within ceiling plenum.

C. Wire and Rod Hangers: Install plumb.

1. Splay hangers where required to avoid contact with obstructions.
2. Secure Attach securely to building structural elements.
3. Do not attach to steel roof deck.
4. Do not connect or suspend from ducts, pipes, or conduit.

D. Large Obstructions: Install supplemental suspension members and hangers, sized to span across objections and support ceiling loads.

E. Grid Suspension Systems: Install per ASTM C636.

1. Install additional hanger wires or metal supports at lighting fixtures air vents, and other ceiling-mounted equipment.

3.5 INSTALLATION TOLERANCES

A. Deviation from Indicated Position: 1/8 inch in 10 feet, maximum.

B. Deviation from Plumb and Level: 1/8 inch in 12 feet, maximum.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Gypsum board.
2. Fasteners, joint reinforcement, and finishing compounds.
3. Patching existing gypsum board surfaces damaged by work of this Contract.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data.

1. Each type of gypsum board.
2. Cementitious tile backer board.
3. Trim accessories.
4. Sound attenuation blankets.

B. Samples:

1. Trim Accessories: 12-inch lengths of trim other than edge beads and control joints.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store gypsum board inside building, protected from weather and moisture.

1.5 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Panel Products:

1. CertainTeed Corp.
2. Continental Building Products.
3. Georgia-Pacific Gypsum LLC.
4. National Gypsum Company.
5. USG Corporation.

2.2 GYPSUM BOARD FOR INTERIOR APPLICATIONS

A. Fire-Resistant Gypsum Board, Type X: ASTM C1396.

1. Thickness: 5/8 inch.

B. Ceiling Board: ASTM C1396.

1. Thickness: 1/2 inch.

C. Moisture- and Mold-Resistant Gypsum Board: ASTM C1396.

1. Core: See Drawings.
2. Mold Resistance: 10 per ASTM D3273.

2.3 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or C1325.

1. Thickness: 5/8 inch.
2. Mold Resistance: 10 per ASTM D3273.

2.4 ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet.
2. Shapes: LC-bead.

B. Sound Attenuation Blankets: ASTM C665, Type I, unfaced semi rigid mineral wool or fiberglass, thickness shown on Drawings, sized for friction fit.

1. Surface Burning Characteristics: ASTM E84.

    a. Flame Spread: 25 maximum.
    b. Smoke Developed: 50 maximum.

2. Fire Rated Partitions: Insulation type required by fire resistance design referenced on Drawings.
3. Other Partitions: Insulation type as required by STC rating shown on Drawings.
4. Thickness: AS indicated on drawings.

C. Acoustic Sealant: Nonsag, paintable, nonstaining, butyl-free, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90. Supply fire rated sealant for use in fire rated assemblies.

1. Manufacturers and Products:

    a. Accumetric LLC BOSS 824 Acoustical Sound Sealant.
    b. GE Construction Sealants RCS20.
    c. Grabber Construction Products Acoustical Sealant GSC.
    d. Pecora Corporation; AC-20 FTR, AIS-919, and Dependent on fire rating.
    e. Specified Technologies, Inc. Smoke N Sound Acoustical Sealant.
    f. USG Corporation SHEETROCK Acoustical Sealant.
    g. Hilti, Inc. CP509 Smoke and Acoustical Sealant.
    h. Specified Technologies, Inc. Smoke N Sound Acoustical Sealant.

D. Electrical Box Pads: Moldable non-curing one component, intumescent, fire-rated material for through-penetration fire stop systems and sound attenuation systems; self-adhering; minimum 1/8 inch thick.

1. Kinetics Noise Control; Fire-Rated Isobacker.
2. Specified Technologies, Inc.; SpecSeal Firestop Putty Pads.

E. Fasteners for Gypsum Board:

1. Metal Framing 33 mils Thick and Less: ASTM C1002, Type S.
2. Metal Framing Greater than 33 mils Thick: ASTM C954.

F. Fasteners for Tile Backer Board: Board manufacturer's standard, corrosion resistant steel.

G. Laminating Adhesive: Type as recommended for directly adhering gypsum panels to continuous substrate.

H. Joint Materials:

1. Interior Gypsum Board: ASTM C475/C475M; products compatible with substrate and other coatings applied to surface.

    a. Skim Coat For Final Coat of Level 5 Finish: Spray-applied high-build coating.

2. Tile Backer Board: Product recommended by backer unit manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify locations and sizes of framing supports for openings and penetrations.

B. Examine panels for moisture and mold; discard damaged panels.

3.2 Installation - acoustical accessories

A. STC-Rated Assemblies: Follow assembly designs shown on Drawings.

B. Comply with ASTM C919 for locations of acoustical sealant beads. Close off sound-flanking paths around or through the work, including sealing of partitions above acoustical ceilings.

C. Do not install sound attenuation blankets until mechanical and electrical work within framing spaces is complete.

D. Fill framing spaces for complete coverage after gypsum board has been installed on one side of partition.

E. Fit sound attenuation blankets tight around cut openings and penetrations, and behind and around electrical and mechanical items within framing spaces.

F. Pack blankets around door and window frames, between jamb studs, in boxed headers, and in other voids.

G. Provide wires or other means of mechanical supports to maintain full coverage and prevent insulation displacement.

H. Where concealed acoustical sealant beads are required at floor line, apply sealant to clean floor surface first and set gypsum boards into wet sealant.

I. At other locations tool beads to ensure complete contact with joint surfaces. Where exposed, form smooth concave surface suitable for finish painting.

J. Ceilings:

1. Install blankets in continuous layer with tightly butted edges.
2. Place blankets over pipes, wiring, electrical boxes, and other construction without voids.

3.3 ELECTRICAL BOX SEALS

A. Install seals before installing gypsum board.

B. Overlap front edge of box so that seals will be compressed around edges of box as gypsum panels are installed.

C. Applications:

1. Electrical boxes in fire barriers, smoke barriers, and STC-rated walls.
2. Electrical boxes at interior gypsum board faces of exterior walls.

3.4 INSTALLATION - INTERIOR GYPSUM BOARD

A. Comply with ASTM C840.

1. Fire-Rated Partitions: Comply with tested designs referenced on Drawings.
2. Acoustically-Rated Partitions: Comply with tested designs referenced on Drawings.

B. Cementitious Backer Units: Comply with ANSI A108.11.

1. Locations: walls behind tile.

C. Cut panels to fit obstructions and openings without tearing face paper or cracking core.

D. Install panels with face side out with lightly butted joints.

E. Stagger joints on opposite sides of partitions.

F. Locate panel ends over support framing.

G. Fit panels to ducts, pipes, conduit, and other penetrations and obstructions with maximum 1/4 inch joints.

H. Attach gypsum board to framing and to supplementary framing and blocking provided for additional support at openings and cutouts.

I. Form control joints and expansion joints with space between edges of boards, prepared to receive trim accessories.

J. Isolate perimeter of non-loadbearing drywall partitions from structural members. Provide 1/4 to 1/2-inch space and trim edge with edge bead. Seal joints with acoustical sealant.

K. Single Layer Installation:

1. Install panels vertically with long edges on continuous supports.
2. Attach panels to framing with screws.

L. Double Layer Installation:

1. Attach base layer to framing with screws.
2. Offset second layer joints and attach panels with screws.
3. At walls taller than 10 feet, install panels horizontally and provide control joints at floor lines.

3.5 INSTALLATION - TRIM

A. Vertical Trim: Install in single pieces where length is 9 feet or less.

B. Control Joints: Provide where shown on Drawings or according to ASTM C 840.

1. Locations of control and expansion joints in substrate or framing.
2. Walls:

    a. At changes in backup material.
    b. Above one jamb of doors, unless door frame extends to ceiling.
    c. Maximum 30 feet on center.

3. Ceilings:

    a. At locations where ceiling framing or furring changes direction.
    b. Maximum 50 feet on center.

C. Corner Trim: Outside corners.

D. Casings: Install at termination joints with other construction or where edges are exposed.

3.6 FINISHING

A. Reference Standard: ASTM C840.

B. Finish panel joints, inside corners, trim flanges, fastener heads, and surface defects to provide smooth, continuous surfaces of monolithic appearance that are suitable for applied finishes.

C. Do not fill spaces around penetrations through fire resistive assemblies with joint compound. Leave space for firestopping.

D. Finish Levels:

1. Level 1: Surfaces in plenums and other concealed areas.
2. Level 2: Surfaces that receive tile and wall paneling.
3. Level 3: Surfaces that receive heavy texture finish or wall coverings and Surfaces with wall paneling with open joints.
4. Level 4: Surfaces that receive flat or low sheen paint and wall coverings,
5. Level 5: Surfaces that receive semigloss or gloss paint and Surfaces to receive graphic vinyl graphic or mural wall.

3.7 IDENTIFICATION

A. Identify fire rated walls and partitions and other walls required to have protected openings or penetrations effectively and permanently with signs or stenciling above accessible ceilings.

1. Locations: Within 4 ft of corners and maximum 12 feet between on both sides.

    a. In spaces without ceilings, locate signs minimum 10 ft above finish floor and not blocked from view by ducts, structure, or other elements.

2. Signs: Painted stencil signs with minimum 4-inch high letters and 1/2-inch strokes, or as required by authorities having jurisdiction, or approved self-adhesive signs.

3. Text: Use following or as required by authorities having jurisdiction.

    a. 1-HOUR FIRE AND SMOKE BARRIER – FIRESTOP ALL PENETRATIONS.
    b. 2-HOUR FIRE AND SMOKE BARRIER – FIRESTOP ALL PENETRATIONS.
    c. NON-RATED SMOKE PARTITION - SEAL ALL PENETRATIONS.

3.8 FIELD QUALITY CONTROL

A. Coordinate installation of gypsum board ceilings, soffits, and bulkheads to accommodate observations by architect and authorities having jurisdiction.

3.9 ADJUSTING

A. Remove interior gypsum products exposed to water during construction period. Remove entire gypsum board panels; do not cut and patch gypsum board.

3.10 CLEANING

A. Remove spills, spatters, and misapplications of finishing materials as they occur.

B. Repair other finish surfaces damaged during drywall operations.

3.11 PROTECTION

A. Protection:

1. Protect adjacent surfaces from gypsum panel compounds, adhesives, and sealants
2. Protect finished gypsum panels from being marred from ongoing work.

END OF SECTION

SECTION 09 30 00

TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Porcelain Floor Tiles at Restrooms
2. Porcelain Wall Base at Restrooms

B. Principal Products

1. Porcelain floor tiles
2. Ceramic Wall tiles
3. Porcelain wall base tiles
4. Ceramic wall base tiles
5. Stone Thresholds
6. Waterproofing and crack isolation membrane.
7. Mortar
8. Grout
9. Metal edge strips.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate tile work with floor, partition and utility work. .

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Tile and tile trim.
2. Mortar.
3. Grout.

a. Provide initial selection color samples.

4. Membranes.

5. Metal trim.

B. Shop Drawings.

1. Locations of control and expansion joints.

C. Samples:

1. Tile: Full sized samples of each type and color.
2. Stone thresholds: 6 inch long section by full width.
3. Metal Trim: 12 inch long section.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Reports: Field inspection reports.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:

1. Tile and Trim Units: Full-size units equal to 3 percent of each product, minimum.

1.6 QUALITY ASSURANCE

A. Qualifications:

1. Tile Subcontractor: Five-Star member of the National Tile Contractors Association.
2. Contractor's Supervisor: International Masonry Institute's Foreman Certification.

B. Field Samples: Construct floor tile installation and wall tile installation, 48 by 48 inches, minimum size.

1. Approved samples establish work results standard.
2. Sample may remain as part of Work.

C. Source Limitations:

1. Provide mortar and grout for each installation from single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store tile and cementitious materials indoors, elevated above grade.
2. Prevent liquid materials from freezing.

1.8 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.

PART 2 - PRODUCTS

2.1 TILE PRODUCTS

A. Ceramic and PorcelainTile Floors and Walls: ANSI A137.1.

1. Manufacturers and Products: See Finish Legend on Drawings.
2. Tile Size: See Finish Legend in Drawings.
3. Color: Architect selected.
4. Grout Color: Architect selected.

2.2 TRIM AND ACCESSORIES

A. Trim Units: Coordinated with colors, sizes, and coursing of adjoining flat tile.

B. Shapes: See Finish Legend on Drawings.

C. Shapes:

1. Base: See Finish Legend on Drawings..

D. Stone Thresholds:

1. Profile: See Drawings.

a. Height: 1/2 inch maximum above adjacent floor finish.

2. Manufacturers and Products: See Finish Legend on Drawings.
3. Marble Thresholds: ASTM C503, with a minimum abrasion resistance of per ASTM C 1353 or ASTM C 241 and with honed finish.

a. Color and Pattern: .

4. Granite Thresholds: ASTM C615 with finish.

a. Color and Pattern: .

5. Slate Thresholds: ASTM C629 with honed finish.

a. Color and Pattern: .

2.3 METAL TRIM

A. Metal Strips: Transitions and Finishing Edges.

1. Manufacturers:

    a. Schluter Systems.
    b. Blanke Corporation.
    c. Ceramic Tool Company.

2. Shapes: Architect selected.
3. Height: Align exposed surfaces with tile and setting bed thickness.
4. Material: Architect selected.
5. Finish: Architect selected.

2.4 MORTAR MATERIALS

A. Modified Dry-Set Cement Mortar: ANSI A118.4.

1. Manufacturers and Products:

    a. ARDEX N 28.
    b. Custom Building Products ProLite.
    c. Laticrete 254 Platinum Thinset.
    d. MAPEI UltraFlex 3.
    e. Merkrete 735 Premium Flex.

2. Manufacturers and Products:

    a. ARDEX X 5.
    b. Custom Building Products VersaBond Flex.
    c. Laticrete 253 Gold Thinset Mortar.
    d. MAPEI Kerabond T / Karalastic.
    e. Merkrete 855 XXL One-Step Adhesive.

B. Improved Modified Dry-Set Cement Mortar: ANSI A118.15.

1. Manufacturers and Products:

    a. ARDEX N 23.
    b. Custom Building Products MegaLite.
    c. Laticrete 220 Marble Granite.
    d. MAPEI UltraFlex 3.
    e. Merkrete 735 Premium Flex.

2. Manufacturers and Products:

    a. ARDEX X 5.
    b. Custom Building Products ProLite.
    c. Laticrete 4-XLT.
    d. MAPEI UltraFlex LFT.

e. Merkrete 820 Merlite.

2.5 GROUT MATERIALS

A. Grout - General:

1. Sanded Grout: Joints over 1/8 inch wide.
2. Unsanded Grout: Joints 1/8 inch and less.

B. High Performance Cement Grout: ANSI A118.7.

1. Manufacturers and Products:

a. ARDEX FL Rapidset.
b. Custom Building Products Prism Ultimate Performance.
c. Laticrete PERMACOLOR Select.
d. MAPEI Ultracolor Plus FA.
e. Merkrete 820 Merlite.

2. Color: Architect selected.

C. 100 Percent Solids Epoxy Grout: ANSI A118.3.

1. Manufacturers and Products:

a. ARDEX WA.
b. Custom Building Products CEG Lite.
c. Laticrete SPECTRALOCK Pro.
d. MAPEI Kerapoxy.
e. Merkrete 820 Merlite.

2. Color: Architect selected.

D. High Performance Single-Component Tile Grout: ANSI A118.7.

1. Manufacturers and Products:

a. Custom Building Products Fusion Pro Designer Series.
b. Laticrete SpectraLOCK Pro Premium.
c. MAPEI Flexcolor CQ.

2. Color: Architect selected.

2.6 WATERPROOFING CRACK ISOLATION MEMBRANE

A. Waterproofing and Crack IsolationMembrane: At Contractor's option, use fluid-applied membrane.

B. Fluid-Applied Waterproofing and Crack Isolation Membrane: ANSI A118.10 and ANSI A118.12, unreinforced latex-rubber or elastomeric polymer.

1. Manufacturers and Products:

    a. Custom Building Products RedGard.
    b. Ardex 8+9 and S1-K.
    c. Laticrete HYDRO BAN.
    d. MAPEI Mapelastic HPG.
    e. Merkrete Hydro-Guard 1.

C. Accessory Products: Membrane manufacturer's primers, adhesives, reinforcing strips, transition mesh, joint sealants, and other products required for a complete installation.

D. Sound Control Underlayment: ANSI A108.13, bonded flexible sheet membrane.

1. Manufacturers and Products:

    a. Custom Building Products EasyMat.
    b. LATICRETE 170 Sound & Crack Isolation Mat
    c. Noble Company NobleSeal SIS
    d. Mapei Mapesonic RM

2.7 MISCELLANEOUS MATERIALS

A. Grout Sealer: Color-enhancing water repellent.

1. Manufacturers and Products:

    a. Custom Building Products Aqua Mix Penetrating Sealer.
    b. Mapei UltraCare Penetrating Plus Stone Tile and Grout Sealer.
    c. PROSOCO Stand Off STMP.

2.8 SEALANTS

A. Joint Sealants: Specified in Section 07 92 00 - Joint Sealants.

1. Color: Architect Selected.

2.9 PERFORMANCE

A. Dynamic Coefficient of Friction: Tested per ANSI A137.1 DCOF AcuTest.

1. Level Floor Surfaces: 0.42 minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that substrates are ready to receive tile work, are firm, dry, clean, free of incompatible coatings, and comply with ANSI A108.01.

3.2 PREPARATION

A. Concrete Substrates: Section 09 05 61 "Common Work Results for Flooring Preparation".

1. Fill cracks, voids, and depressions in substrate with leveling compound.
2. Grind off high spots and projections in substrate.
3. Remove loose and foreign matter that could impede performance of tile.

3.3 TILE INSTALLATION

A. Install tile and grout per ANSI A108.1 through ANSI A108.10 requirements and TCNA Handbook recommendations.

1. Install thresholds, edge strips, and trim.

B. Waterproofing and Crack Isolation Membranes: Install per ANSI A108.13 and ANSI A108.17.

1. Verify that liquid-applied waterproofing membranes have minimum 20-mil dry film thickness.

C. Lay out tile to minimize pieces less than half size. Locate cuts to be inconspicuous.

D. Lay tile to patterns shown on Drawings. Do not interrupt tile pattern through openings.

E. Place thresholds and edge strips at locations indicated.

F. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor, base and wall joints.

G. Place tile with joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.

H. Joint Widths: Not less than recommended by manufacturer, and as follows:

1. Porcelain Tile:1/16 inch.

I. Form internal angles square and external angles bullnosed.

J. Sound tile after setting. Replace hollow sounding units.

K. Control Joints: Provide control joints at following locations:

1. Changes in backup material.
2. Changes in plane.
3. Over joints in substrate.
4. Form joints per TCNA Method EJ-171.

L. Install joint backing and joint sealer as specified in Section 07 92 00.

M. Stone Thresholds: Install in same setting material as adjacent floor.

N. Metal Edge Strips: Install where shown on Drawings.

O. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes per Section 07 92 00.

P. Grout Sealer: Apply to cementitious grout joints. Remove excess.

3.4 CLEANING

A. Cleaning: Clean tile and grout surfaces so they are free of foreign matter. Remove grout residue, smears and haze.

B. Remove temporary wax coating from quarry tile.

C. Protect tile with kraft paper or other covering to prevent damage and wear. Prohibit foot and wheeled traffic for seven days, minimum, after grouting.

3.5 INSTALLATION SCHEDULE - INTERIOR FLOOR TILE

A. Floors over Concrete - Thinset: Installation Method TCNA F113.

1. Tile: Porcelain.
2. Bond Coat: Improved Modified dry-set cement mortar.
3. Grout: High-performance cement grout.

B. Floors over Wood Subfloor - Unbonded Mortar Bed: Installation Method TCNA F141.

1. Tile: <Designation>.
2. Membrane: .
3. Bond Coat: dry-set cement mortar.
4. Grout: .

3.6 INSTALLATION SCHEDULE - INTERIOR WALL TILE

A. Walls over Concrete or Masonry - Unbonded Mortar Bed: Installation Method TCNA W221 with waterproof membrane.

1. Tile: <Designation>.
2. Membrane: Fluid-applied.
3. Bond Coat: Modified dry-set cement mortar.

4. Grout: High-performance cement grout.

B. Walls over Cementitious Backer Board on Metal Studs - Thinset: Installation Method TCNA W244.

1. Tile: <Designation>.
2. Membrane: Fluid-applied.
3. Bond Coat: Modified dry-set cement mortar.
4. Grout: High-performance cement grout.

END OF SECTION

SECTION 09 51 13

ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Suspended acoustical ceiling panels and exposed suspension systems for ceilings.

B. Principal Products

1. Mineral fiber acoustic ceiling panels.
2. Fiberglass acoustic cloud panel (Alternate) at Lobby.
3. Suspended grid system.

C. Related Requirements

1. Section 09 54 26 Suspended Wood Ceilings (Base Bid at Lobby)

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate work results of this section with ceiling-supported elements..

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

C. Sequencing Procedures

1. Install acoustical ceilings after building is enclosed, HVAC system is operating at occupancy levels, dust-generating activities are complete, and overhead work is completed, tested, and approved.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Acoustical panels.
2. Suspension grid and trim.
3. Initial selection color and texture.

B. Shop Drawings.

1. Show grid layout and panel identification for each acoustical panel ceiling.
2. Include mechanical and electrical items installed in ceilings.
3. Installation details for seismic design loads sealed by professional engineer responsible for design of seismic attachment and bracing..

C. Samples:

1. Each required type of acoustical panel in standard size.
2. Each type of suspension grid in 12-inch lengths with required colors.
3. Extruded aluminum trim in 12-inch lengths with required colors.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Warranty Documentation: For acoustical ceilings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver products until building is fully enclosed.

B. Storage and Handling Requirements:

1. Store acoustical panels indoors, protected from soiling and other damage.

1.6 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations:

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.

B. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANELS

A. Acoustical Panels: ASTM E1264.

1. Manufacturers and Products: See Finish Schedule on Drawings.

2.2 SUSPENSION GRID

A. Metal Suspension System:

1. Manufacturers and Products: See Finish Legend on Drawings.

B. Fire-Rated Grid: Same attributes as non-rated grid, but listed by UL for indicated fire-resistance rating.

1. Hold-Down Clips: As used in tested and listed assembly.

C. Impact Clips: Supplied by ceiling system manufacturer.

D. Touch-up Paint: Type and color to match acoustic and grid units.

2.3 CEILING tRIM

A. Wall Moldings:

1. Material: Architect selected, painted finish matching grid.
2. Profile: Architect selected..

B. Decorative Ceiling Edge Trim: Extruded aluminum with concealed attachment to suspension grid and flush, splined joints; factory-painted finish.

1. Height: See Drawings.
2. Color: Architect selected and See Drawings.

2.4 iNSTALLATION MATERIALS

A. Hanger Attachment: Five times design load per ASTM C635, Table 1.

B. Wire Hangers: Galvanized steel wire in diameter for three times hanger design load per ASTM C635, Table 1.

C. Rigid Hangers: One of the following types.

1. Rods: Mild steel, minimum 1/4 inch diameter, hot-dip galvanized per ASTM A153.`
2. Flat Strap: Mild steel, minimum 1 by 1/8 inch size, hot-dip galvanized per ASTM A153.
3. Angles: Formed steel sheet, minimum 7/8 inch legs and 0.040 thickness, G90 hot-dip galvanized per ASTM A653.

D. Carrying Channels: Cold-rolled, C-shaped steel channels, minimum 0.053-inch base-metal thickness, with minimum 1/2-inch- wide flanges.

1. Depth: 1-1/2 inches.
2. Protective Coating: hot-dip galvanized per ASTM A653.

E. Acoustical Insulation: ASTM C665; unfaced fiberglass blankets.

2.5 PERFORMANCE

A. Delegate <Product or system> design to manufacturer's licensed Professional Engineer.

B. Structural Design Criteria: See Structural Drawings.

2.6 FABRICATION

A. Fabricate decorative edge trim at factory to accurate curves that are free of flat spots, kinks, or other distortion.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that layout of hangers will not interfere with other work.

B. Examine acoustical panels; discard panels that are wet, damaged, or exhibit mold.

C. Verify that major work above ceiling is complete before installing grid.

3.2 INSTALLATION

A. Installation Reference Standards:

1. ASTM C636 - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
2. CISCA Ceiling Systems Handbook.

B. Install ceiling system capable of supporting imposed loads with 1/240 of span deflection, maximum.

C. Locate system on room axis according to reflected plan.

D. Lay out system to balanced grid design with edge units not less than 50 percent of acoustic unit size. Arrange system with long dimension of tile to long dimension of the space.

E. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

F. Space hanger wires maximum 48 inches on center. Install additional hangers as needed to support light fixtures and ceiling supported equipment without exceeding deflection limit.

G. Where ducts or other equipment prevent regular spacing of hangers, reinforce hangers to span extra distance or suspend steel channel horizontally beneath duct or equipment for hangers.

H. Install decorative edge trim with plumb faces, concealed fasteners, and aligned joints.

I. Install grid so that components are level, accurately aligned, and free of rotation.

J. Perimeter Molding: Screw attach at 16 inch centers, maximum.

1. Install edge molding at intersection of ceiling and vertical surfaces .
2. Use longest practical lengths.
3. Install at junctions with other interruptions.
4. Outside Corners: Miter or overlap molding.
5. Inside Corners: Cut flange and bend web.
6. At round obstructions or penetrations, install factory-formed closures that match perimeter molding.

K. Support ends of tees on flange of perimeter molding.

L. Rated Ceilings: Install light fixture boxes of gypsum board and acoustical panels per UL assembly requirements and fixture ventilation requirements.

M. Do not install acoustical panels until all work above ceiling is complete.

N. Lay directional pattern units with pattern running one direction.

O. Place acoustical panels with edges resting flat on suspension grid in uniform plane free of warping.

P. Cutting Acoustical Panels:

1. Cut to fit irregular grid and perimeter edge trim.
2. Cut edges to match factory edges.
3. Field paint exposed cut edges.

Q. Lay acoustical insulation blankets in close contact to distance of 48 inches on both sides of partitions with acoustical insulation.

3.3 TOLERANCES

A. Plane: 1/8 inch maximum variation in 10 feet measured in any direction.

B. Grid and Trim Plumbness: Maximum 2 degrees of rotation.

3.4 ADJUSTING

A. Touch up minor scratches and abrasions to match factory finish.

B. Provide new components to replace damaged components that cannot be satisfactorily cleaned or repaired.

END OF SECTION

SECTION 09 54 26

SUSPENDED WOOD CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Suspended exterior wood panel ceiling at canopy soffit.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate layout and installation of wood panels and suspension system with other construction that penetrate ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.<work results of this Section> with <other work>.

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

C. Sequencing Procedures:

1. Install interior wood ceilings after building is enclosed, HVAC system is operating at occupancy levels, dust-generating activities are complete, and overhead work is completed, tested, and approved.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Interior Wood Panels.
2. Exterior Wood Panels.

B. Shop Drawings:

1. Show grid layout and panel identification for each wood ceiling.
2. Include mechanical and electrical items installed in ceilings.

C. Samples:

1. Wood Panels with exposed screws or rivets: 12 inch by 12 inch size

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Tools: Manufacturer's recommended special tools required to maintain .

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installers: Experienced specialty firm with trained mechanics.

1.6 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.

B. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 exTERIOR WOOD PANEL CEILING SYSTEM

A. Manufacturer and product: See Finish Legend on Drawings.

B. Subframe Members: Manufacturer standard aluminum.

C. Hat channel: Manufacturer's standard aluminum furring channels.

D. Fasteners: Manufacturer's standard exposed screws or rivets, color and finish as selected by Architect.

E. Finish Color: See Finish Legend on Drawings.

2.2 suspension system for interior wood panels

A. Grid: ASTM C635, heavy duty.

B. Material: Steel; ASTM A653 G30 hot dip galvanized.

C. Width: 9/16 inch.

D. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure panels in place.

2.3 screws, rivets, and other accessories

A. Manufacturer's standard products.

B. Finish: Architect selected.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions

1. Verify that layout of hangers will not interfere with other work.
2. Verify that major work above ceiling is complete before installing grid.
3. Examine ceiling panels; discard panels that are wet, damaged, or exhibit mold.

3.2 installation

A. Installation Reference Standards

1. ASTM C636 - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
2. CISCA Ceiling Systems Handbook.
3. nstall suspension system in accordance with ASTM E580/E580M and CISCA for Seismic Zones 0-2.
4. Install ceiling system capable of supporting imposed loads with maximum 1/360 deflection.

B. Locate suspension system for linear panel layout as indicated on Drawings.

C. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

D. Space hanger wires maximum 48 inches on center. Install additional hangers as needed to support light fixtures and ceiling supported equipment without exceeding deflection limit.

E. Where ducts or other equipment prevent regular spacing of hangers, reinforce hangers to span extra distance or suspend steel channel horizontally beneath duct or equipment for hangers.

F. Install wood panels with undamaged edges and fit accurately into suspension system runners. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

G. Follow manufacturer's instructions for spacing between panels and perimeter wall.

3.3 Tolerances

A. Plane: 1/8 inch maximum variation in 10 feet measured in any direction.

3.4 adjusting and CLEANING

A. Replace damaged and broken panels.

B. Cleaning: Clean exposed surfaces of ceilings panels assembly. 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 09 65 00

RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Resilient Tiles
2. Resilient Base and Accessories

B. Principal Products

1. Luxury Vinyl Tile LVT-1, LVT-2, LVT-3, LVT-4
2. Resilient Wall Base RB-1

1.2 ADMINISTRATIVE REQUIREMENTS

1.3 ACTION SUBMITTALS

A. Product Data:

1. Resilient flooring products.
2. Resilient accessories.
3. Installation materials.
4. Initial selection color samples.

B. Shop Drawings.

1. Accent Flooring: Layout.

C. Product Schedule: Resilient flooring products.

D. Samples:

1. Resilient Tile Flooring: Full sized samples of each product.
2. Resilient Base: 12 inch length of each product.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For resilient flooring.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:

1. Resilient Tile Flooring: One box for every 50 boxes of installed tile.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store resilient flooring indoors and within ambient temperature range recommended by manufacturer.
2. Store resilient tile flooring on flat surfaces.

1.7 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.
2. Temperature Range: 70 degrees F, minimum, 85 degrees F, maximum.
3. Establish ambient conditions 48 hours, minimum before and maintain conditions during and 48 hours, minimum after installation.

B. Install resilient flooring after all other interior finishing is completed.

C. Do not allow traffic on resilient flooring until 48 hours after installation.

PART 2 - PRODUCTS

2.1 RESILIENT TILE FLOORING

A. Luxury Vinyl Floor Tile: ASTM F1700.

1. Manufacturers and Products: See Finish Schedule on Drawings.
2. Type: B, Embossed Surface.
3. Thickness: 0.125.

B. Rubber Floor Tile: ASTM F1344.

1. Manufacturers and Products: See Finish Legend on Drawings.
2. Class: Class 1.
3. Overall Thickness: 0.125 inch and 0.14 inch.
4. Size: See Finish Legend on Drawings.

2.2 RESILIENT BASE

A. Rubber Base: ASTM F1861 Type TS.

1. Manufacturers and Products: See Finish Legend on Drawings.
2. Style: See Finish Schedule.
3. Height: See Drawings.
4. Inside Corners: Job formed.
5. Outside Corners: Job formed.
6. Color: See Finish Legend on Drawings.

2.3 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Class perNFPA 253, Critical Radiant Flux Classification.

2.4 INSTALLATION MATERIALS

A. Patching and Leveling Materials: Products recommended by flooring manufacturer for indicated substrates.

B. Edge Strips: Rubber and Vinylin indicated profiles.

1. Colors: Architect selected.

C. Adhesives: Flooring manufacturer's recommended water-based product.

1. Maximum VOC Content: 50 grams per liter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that concrete floors have cured minimum 28days.

B. Verify that moisture content and alkalinity are within flooring manufacturer’s recommended limits.

1. Where testing indicates that the concrete slab exceeds moisture content or alkalinity limits, treat floor per Section 09 05 61 and retest.

3.2 PREPARATION

A. Concrete Substrates: Comply with Section 09 05 61 "Common Work Results for Flooring Preparation."

3.3 TILE FLOORING INSTALLATION

A. Mix materials from multiple containers for consistent blend of colors.

B. Lay out tiles so that units at opposite walls are equal width and more than half size.

C. Install tiles in pattern on Drawings and directed by Architect.

D. Extend tile into recesses and under equipment.

E. Terminate tile flooring at centerline of doors where adjacent floor finish is dissimilar.

F. Scribe and cut tile for close fit at vertical surfaces so that cut edge will be concealed by wall base or other trim.

G. Install tile with full adhesive coverage.

H. Roll tile to eliminate entrapped air and ensure full adhesion.

I. Install edge strips where tile terminate against dissimilar flooring. Butt end seams tight.

3.4 CLEANING AND PROTECTION

A. Remove adhesive from visible surfaces.

B. Do not allow traffic on flooring until adhesive has fully set.

C. Provide surface protection at areas subject to traffic during construction period.

END OF SECTION

SECTION 09 90 00

PAINTING AND COATING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Site applied paints.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Initial selection color samples.

B. Samples:

1. Draw Down Samples: Each type of paint system and each topcoat color and gloss.

a. Label each Sample for paint type, location, and substrate.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data:

1. Cleaning, touch-up, and repair instructions for painted and coated surfaces.
2. Area summary with finish schedule and color samples, designating where each product, color and finish was used.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials:

1. Paint from same product run as installed materials.

a. Quantity: 5 percent, but not less than 1 gallon of each material and color..

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store paint products in sealed containers until ready for use.

1.7 FIELD CONDITIONS

A. Apply materials only when surface and ambient temperatures are within temperature ranges required by paint product manufacturer.

B. Apply exterior coatings when rain or snow are not occurring or forecasted, and when relative humidity is inside humidity ranges, and moisture content of surfaces is within acceptable levels required by paint product manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS [AND PRODUCTS]

A. Colors by Basis of Design Manufacturer's Designations: See Finish Legend on Drawings.

B. Products: Scheduled in this Section.

2.2 PAINT, GENERAL

A. Paint Systems: Primers, intermediate coats and topcoats compatible with substrates and one another.

B. Coatings: Ready mixed or field-catalyzed.

C. Preparation:

1. Mix to soft paste consistency, capable of being readily and uniformly dispersed to homogenous coating.
2. Blend tints and catalyzers to uniform consistency and color, capable of drying or curing free of streaks or sags.

2.3 SOURCE QUALITY CONTROL

A. Tests:

1. Testing: Owner may engage a qualified testing agency to sample paint materials delivered to project site or taken from supplier's facility.
2. Acceptance Criteria: Products comply with specified requirements.

B. Non-Conforming Work: Remove materials from substrates, pay for testing of replacement products, and repaint surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify substrates are ready to receive work.

B. Preinstallation Testing: Test moisture content of substrate does not exceed the following:

1. Concrete: 12 percent.
2. Fiber-Cement Board: 12 percent.
3. Masonry: 12 percent.
4. Wood: 15 percent.
5. Portland Cement Plaster: 12 percent.
6. Gypsum Board: 12 percent.

C. Concrete and Masonry: Verify surface has cured at least 30 days and that the pH of the surface is between 6 and 9.

3.2 PREPARATION

A. Surface Preparation: Remove electrical plates, hardware, trim, escutcheons, and fittings. Correct defects in substrates capable of affecting work.

B. Cleaning: Remove substances that could impair paint bond, including dust, oil, grease, and incompatible coatings.

1. Concrete and CMU Surfaces: Remove dirt, loose mortar, scale, efflorescence and chalk. Remove oil and grease by scrubbing with cleaning solution recommended by finish coating manufacturer. Rinse with clean water and allow surface to dry.
2. Galvanized Surfaces: Remove surface contamination and oils by mechanical methods to produce clean, lightly etched surfaces.
3. Uncoated Steel: Remove rust and loose mill scale. Clean per SSPC-SP 2 "Hand Tool Cleaning" and SSPC- SP 3 "Power Tool Cleaning".
4. Primed Steel: Clean field welds, fasteners, and abraded shop primer.
5. Wood Surfaces:

    a. Wipe off dust and grit. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried.
    b. Backprime concealed surfaces.

3.3 APPLICATION

A. Follow manufacturer's instructions for application method, thickness of coatings, and number of coats.

1. Apply finishes when surfaces are dry. Allow applied coats to dry before next coat is applied.
2. Apply each coat of paint slightly darker than preceding coat.
3. Apply coatings to uniform appearance.
4. Sand wood and metal surfaces lightly between coats.
5. Leave testing agency, equipment identification, and performance labels unpainted.

B. Appearance:

1. Apply paints without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, or other imperfections.
2. Edges and Color Breaks: Produce sharp edges.

3.4 PAINTING MECHANICAL EQUIPMENT

A. Paint the following equipment when exposed in As directed by Architect:
1. Piping.

3.5 CLEANING

A. Cleaning:

1. Remove rubbish, empty cans, rags, and other discarded materials.
2. Remove splattered paints. Protect adjacent surfaces from damage.

3.6 PROTECTION

A. Protection: Protect painted surfaces from subsequent construction work. Touch up and restore damaged painted surfaces.

3.7 INTERIOR PAINTING SCHEDULE

3.8 EXTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Latex Block Filler:

   a. Basis of Design: Sherwin-Williams: Conflex XL Block Filler, CF01W50.
   b. BEHR: Behr Pro Block Filler Primer, PR50.
   c. Benjamin Moore: Ultra Spec® Masonry Hi-Build Block Filler 571.
   d. PPG Paints; Perma-Crete Concrete Block & Masonry Surfacer/Filler.

2. Exterior Latex Topcoat: Eggshell finish.

   a. Basis of Design: Sherwin-Williams: A100 Series Exterior Latex.
   b. BEHR: PRO e600 Exterior Paint.
   c. Benjamin Moore: Ultra Spec Exterior Enamel.
   d. PPG Paints: SPEEDHIDE Exterior Latex

B. Unprimed Ferrous Metal:

1. Primer:

   a. Basis of Design: Sherwin-Williams: Kem Bond HS, B50 Series
   b. BEHR: Interior/Exterior Metal Primer 435.
   c. Benjamin Moore: Super Spec HP Alkyd Metal Primer P06.
   d. PPG Paints: Multiprime/Devguard 4360.

2. Latex Topcoat: Semi-gloss finish.

   a. Basis of Design: Sherwin-Williams: Pro Industrial Acrylic B66-600 Series.
   b. BEHR: PREMIUM Direct to Metal Semi-Gloss Paint 3200.
   c. Benjamin Moore: Ultra Spec HP D.T.M. Acrylic HP29.
   d. PPG Paints: Pitt-Tech Plus Interior/Exterior DTM Industrial Enamel 4216 Series

C. Galvanized Steel:

1. Primer:

   a. Basis of Design: Sherwin-Williams: Pro Industrial ProCryl Universal Primer.

b. BEHR: PREMIUM PLUS Exterior Multi-Surface Primer & Sealer 436.
c. Benjamin Moore: Ultra Spec HP D.T.M. Acrylic HP29.
d. PPG Paints: Seal Grip Interior/Exterior Acrylic Universal Primer/Sealer 17-921.

2. Latex Topcoat: Semi-gloss finish.

a. Basis of Design: Sherwin-Williams: Pro Industrial Acrylic B66-600 Series.

b. BEHR: PREMIUM Direct to Metal Semi-Gloss Paint 3200.
c. Benjamin Moore: Ultra Spec HP D.T.M. Acrylic HP29.
d. PPG Paints: Pitt-Tech Plus Interior/Exterior DTM Industrial Enamel 4216 Series

D. Concrete: Elastomeric Coating system.

1. Primer:

a. BEHR: Multi-Surface Interior/Exterior Stain-Blocking Primer & Sealer 436.
b. Benjamin Moore: Ultra Spec Interior/Exterior Masonry Sealer 608.
c. PPG Paints: PERMA-CRETE Interior/Exterior Alkali Resistant Primer 4-603XI.
d. Sherwin-Williams: Loxon Concrete and Masonry Primer/Sealer LX02 Series.

2. Elastomeric Topcoat: Flat finish.

a. BEHR: PREMIUM Elastomeric Masonry, Stocco & Brick Paint 68.
b. Benjamin Moore: Super Spec Masonry Elastomeric Coating 056.
c. PPG Paints: PERMA-CRETE PITT-FLEX Elastomeric Coating 4-110XI.
d. Sherwin-Williams: CONFLEX SHERLASTIC Elastomeric Coating CF16 Series.

E. CMU: Elastomeric Coating system.

1. Block Filler:

a. BEHR: Behr Pro Block Filler Primer, PR50.
b. Benjamin Moore: Ultra Spec Masonry Hi-Build Block Filler 571.
c. PPG Paints; Perma-Crete Concrete Block & Masonry Surfacer/Filler 4-110XI.
d. Sherwin-Williams: Loxon Conflex Block Filler.

2. Elastomeric Topcoat: Flat finish.

a. BEHR: Exterior Elastomeric Masonry, Stucco & Brick Paint 68.
b. Benjamin Moore: Super Spec Masonry Elastomeric Coating 056.
c. PPG Paints: PERMA-CRETE PITT-FLEX Elastomeric Coating 4-110XI.
d. Sherwin-Williams: CONFLEX SHERLASTIC Elastomeric Coating CF16 Series.

END OF SECTION

SECTION 09 96 46

INTUMESCENT PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Surface preparation and application of fire-retardant intumescent paint.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Initial selection color charts or samples.
2. Include manufacturer's recommended spreading rate for each separate coat for each type of substrate indicated.
3. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

B. Samples:

1. Submit Samples on rigid backing, not less than 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

1.3 information SUBMITTALS

A. Material Test Reports: For each intumescent paint.

1.4 QUALITY ASSURANCE

A. MPI Standards: Comply with indicated requirements for the following:
1. Wall Surfaces: Prepare Samples of at least 100 sq. ft..

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store intumescent paint products in tight containers, indoors, protected from elements and secured from theft.

2. Store intumescent paint products elevated above grade, protected from precipitation and stormwater runoff.
3. Handle intumescent paint products with care to prevent damage.

1.6 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. For Interior Application: Building enclosed and environmental systems maintaining design conditions for Owner occupancy.
2. Apply waterborne intumescent paints: 50 degrees F minimum , 90 degrees F, maximum.
3. Apply solvent-thinned intumescent paint: 45 degrees F minimum , 95 degrees F, maximum.
4. Do not apply intumescent paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
5. Allow wet surfaces to dry thoroughly and to attain temperature and conditions specified before starting or continuing coating operation.

PART 2 - PRODUCTS

2.1 INTUMESCENT PAINT MATERIALS, GENERAL

A. Material Compatibility

1. Provide materials for use within each paint system that are compatible with one another and with substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each material or coat, provide products and spreading rates recommended in writing by intumescent paint manufacturer for use on substrate indicated. Comply with requirements for fire-retardant coating classification and surface-burning characteristics indicated.

B. Colors and Gloss: As selected by Architect from manufacturer's full range.

2.2 interior pigmented intumescent paint system

A. Primer: Intumescent paint manufacturer's recommended primer compatible with substrate and other materials indicated.

B. Fire-Retardant Interior Intumescent Paint: Provide the following products:

1. Basis of Design: See Finish Schedule on Drawings.

C. Top Coat/Overcoat: Manufacturer recommended, water-based, latex-type, pigmented, fire-inert, protective-finish coating that will not affect fire-retardant class of intumescent coating.

2.3 exterior pigmented intumescent paint system

A. Primer: Intumescent paint manufacturer's recommended primer compatible with substrate and other materials indicated.

B. Fire-Retardant Exterior Intumescent Paint: Provide the following products:

1. Basis of Design: See Finish Schedule on Drawings.

C. Top Coat/Overcoat: Manufacturer recommended, water-based, latex-type, pigmented, fire-inert, protective-finish coating that will not affect fire-retardant class of intumescent coating.

2.4 PERFORMANCE CRITERIA

A. Surface Burning: ASTM E84, Class A

1. Flame Spread Index: 25 or less
2. Smoke Developed Index: 450 or less

B. Impact resistance: D2794

C. Durometer Hardness: D2240

D. Bond Strength: ASTM D4541

E. Abrasion Resistance: ASTM D4060

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify suitability of substrates, including surface conditions, and compatibility with existing finishes and primers.

B. Examine substrates: Comply with manufacturer's requirements, in the presence of Applicator, for surface treatments, shop primed surfaces, maximum moisture content, and other conditions affecting peformance of Work.

C. Do not proceed with application until unsatisactory conditions have been correct and surfaces are dry.

3.2 PREPARATION

A. Protection of In-Place Conditions: Remove hardware and hardware accessories, plates, machined surfaces, light fixtures, and similar items already installed that are not to be coated. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and coating.

1. Use workers skilled in the trades involved to reinstall items that were removed, when coating operations are completed.
2. Remove surface-applied protection if any.

B. Surface Preparation:

1. Comply with manufacturer's written instructions and recommendations in the "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated."

3.3 INSTALLATION

A. Follow manufacturer's written instructions and comply with requirements for listing and labeling for surface-burning characteristics specified.

END OF SECTION

SECTION 10 14 00

SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Identification Signs.
2. Directory Signs
3. Regulatory Signs
4. Information Signs
5. Sign Illumination

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of sign.
2.

B. Shop Drawings:

1. Indicate sign styles, lettering font, foreground and background colors, locations, overall dimensions of each sign.

C. Signage Schedule: Full signage schedule that includes room identification signs.

D. Verification Samples: Submit two samples 12 x 12 inches of each type of lens, and sign box material indicating finish and color.

1.3 QUALITY ASSURANCE

A. Fabricated Signs: UL approved and labeled.

B. Provide electrical components labeled and listed by Underwriters Laboratories.

C. Comply with applicable NEMA standards for electrical components.

D. Comply with ANSI 117.1 American National Standard and all other state and local laws having jurisdiction, including materials, fabrication, mounting and installation

E.

F. Qualifications:

1. Manufacturer: Firm experienced in producing signs similar to those indicated for this Project, with a record of successful in-service performance, and sufficient production capacity to produce sign units required without causing delay in the Work.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Package signs, labeled in name groups.

1.5 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.

PART 2 - PRODUCTS

2.1 interior signs

A. Signage, General

1. Manufacturers: As selected by Architect.
2. Sign Box: As selected by Architect.
3. Face Panels: Design, custom graphics, and color as selected; removable to service lighting.
4. Finish: Factory paint finished, color as selected and approved by Architect.
5. Lighting: Manufacturer standard lighting, as approved by Architect, to provide uniform face illumination, color as selected.

B. Accessories

1. Fasteners and Supports: Non rusting; types, sizes, and configurations as recommended by the sign manufacturer.

C. Room Identification Signs

1. Manufacturers:

a. Basis of Design: Review with Architect.
b. Approved equal.

2. Room Identification Signs

a. Type: Vinyl sign with number characters and Braille, single piece construction

b. Thickness: Minimum 1/8 inch.
c. Sign Shape: As selected by Architect.
d. Colors: Selected by Architect from manufacturer's full color range.
e. Letter and Number Styles: Selected by Architect from manufacturer's full range
f. Finish: Architect selected.
g. Mounting: Manufacturer standard recommendation.

PART 3 - EXECUTION

3.1 examination

A. Verify that surfaces are ready to receive work.

B. Inspect each sign before installation for damage and defects.

3.2 installation - interior signs

A. Install signs after interior surfaces are finished.

B. Locate sign units and accessories where indicated, using mounting methods of the type described and in compliance with accessibility requirements and the manufacturer's instructions.

C. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

3.3 cleaning and protection

A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

END OF SECTION

SECTION 10 22 26
OPERABLE PARTITIONS

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. This Section includes the following:

B. Related Sections include the following:

1. Division 3 Sections for concrete tolerances required.

2. Division 5 Sections for primary structural support, including pre-punching of support members by structural steel supplier per operable partition supplier's template.

3. Division 6 Sections for wood framing and supports, and all blocking at head and jambs as required.

4. Division 9 Sections for wall and ceiling framing at head and jambs.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the operable partition manufacturer, as qualified to install the manufacturer's partition systems for work similar in material, design, and extent to that indicated for this Project.

B. Acoustical Performance: Test operable partitions in an independent acoustical laboratory in accordance with ASTM E90 test procedure and classified in accordance with ASTM E413 to attain no less than the STC rating specified. Provide a complete and unedited written test report upon request.

C. Preparation of the opening shall conform to the criteria set forth per ASTM E557 "Standard Practice for Architectural Application and Installation of Operable Partitions."

D. The operable wall must be manufactured by a certified ISO-9001-2015 company or an equivalent quality control system.

1.4 REFERENCE STANDARDS

A. ASTM International

1. ASTM E557 Standard Practice for Architectural Application and Installation of Operable Partitions.

2. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

3. ASTM C1036 - Standard Specification for Flat Glass.

4. ASTM C1048 - Heat-Treated Flat Glass—Kind HS, Kind FT Coated and Uncoated Glass.

5. ASTM E84 - Surface Burning Characteristics of Building Materials.

6. ASTM E413 - Classification for Rating Sound Insulation

B. Health Product Declaration Collaborative

1. Health Product Declaration Open Standard v2.1

C. International Standards Organization

1. ISO 14021 - Environmental Labels and Declarations - Self-Declared Environmental Claims (Type II Environmental Labeling).

2. ISO 14025:2011-10, Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures.

3. ISO 14040:2009-11, Environmental Management - Life Cycle Assessment - Principles and Framework.

4. ISO 14044:2006-10, Environmental Management - Life Cycle Assessment - Requirements and Guidelines.

5. ISO 21930 – Sustainability in Buildings and Civil Engineering Works — Core Rules for Environmental Product Declarations of Construction Products and Services.

D. Other Standards

1. ADA – Americans with Disabilities Act.

2. ANSI Z97.1 - Safety Glazing Materials Used in Buildings.

3. CPSC 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

4. NEMA LD3 - High Pressure Decorative Laminates.

1.5 SUBMITTALS

A. Product Data: Material descriptions, construction details, finishes, installation details, and operating instructions for each type of operable partition, component, and accessory specified.

B. Shop Drawings: Show location and extent of operable partitions. Include plans, elevations, sections, details, attachments to other construction, and accessories. Indicate dimensions, weights, conditions at openings, and at storage areas, and required installation, storage, and operating clearances. Indicate location and installation requirements for hardware and track, including floor tolerances required and direction of travel. Indicate blocking to be provided by others.

C. Setting Drawings: Show imbedded items and cutouts required in other work, including support beam punching template.

D. Samples: Color samples demonstrating full range of finishes available by architect. Verification samples will be available in same thickness and material indicated for the work.

E. Reports: Provide a complete and unedited written sound test report indicating glass thickness and spacing in test specimen matches product as submitted.

F. Create spaces that are healthy for occupants.

1. Furnish products and materials with Health Product Declaration (HPD), Manufacturer Inventory, or other material health disclosure documentation. Products without an HPD or other disclosure documentation are not acceptable.

G. Furnish materials that generate the least amount of pollution.

1. Furnish products and materials that have third party verified environmental product declarations (EPD's). Consider products and materials that have optimized environmental performance (reduced life cycle impacts). Products without an EPD or other disclosure documentation are not acceptable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Clearly mark packages and panels with numbering systems used on Shop Drawings. Do not use permanent markings on panels.

B. Protect panels during delivery, storage, and handling to comply with manufacturer's direction and as required to prevent damage.

1.7 WARRANTY

A. Provide written warranty by manufacturer of operable partitions agreeing to repair or replace any components with manufacturing defects.

B. Partition Warranty period: Two (2) years from date of shipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, PRODUCTS, AND OPERATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Modernfold, Inc.

B. Products: Subject to compliance with the requirements, provide the following product:

1. OP-01: Acousti-Seal #933E electrically operated continuously hinged operable partition.

2.2 OPERATION

A. OP-01: Acousti-Seal #933E: Series of continuously hinged flat panels, electrically operated, top supported with operable floor seals.

B. Final Closure:

1. OP-01: Side Jamb

2.3 PANEL CONSTRUCTION

1. OP-01: Roll-formed steel wrapping around panel edge. Panel skins shall be lock formed and welded directly to the frame for unitized construction. Acoustical ratings of panels with this construction minimum:

a. 50 STC

C. Hinges for Panels, Closure Panels, Pass Doors, and Pocket Doors shall be:

1. OP-01: Full leaf butt hinges, attached directly to the panel frame with welded hinge anchor plates within panel to further support hinge mounting to frame. Lifetime warranty on hinges. Hinges mounted into panel edge or vertical astragal are not acceptable.

D. Panel Trim: No vertical trim required or allowed on edges of panels; minimal groove appearance at panel joints.

E. Panel Weights:

1. OP-01: 50 STC - 8 lbs./square foot

2.4 PANEL FINISH

A. Panel finish shall be:

1. OP-01: Reinforced vinyl with woven backing weighing not less than 21 ounces (595 grams) per lineal yard.

B. Panel Trim: Exposed panel trim of one consistent color:

1. OP-01: To Be Advised

2.5 SOUND SEALS

A. Vertical Interlocking Sound Seals between panels: Roll-formed steel astragals, with reversible tongue and groove configuration in each panel edge for universal panel operation. Rigid plastic or aluminum astragals or astragals in only one panel edge are not acceptable.

B. Horizontal Top Seals: Continuous contact extruded vinyl bulb shape with pairs of non-contacting vinyl fingers to prevent distortion without the need for mechanically operated parts.

C. Horizontal bottom floor seals shall be:

1. OP-01: Modernfold Floating Bottom Seal. Floating operable seals provide nominal 3.50 (89mm) operating clearance with an operating range of +.50" (15mm) to -3" (76mm) and

shall provide continuous floor contact as panels are positioned without the need for tools or cranks. Seal shall be operable from either panel edge to permit multiple panel position and reversible operation.

2.6 SUSPENSION SYSTEM

A. OP-01: #30 Suspension System

1. Suspension Tracks: Track shall be structural aluminum. Static loading of track with brackets at 48-inch (1220 mm) centers shall show no failure of track or brackets at 5,000 pounds (2250 kg) point loading at mid-span. Track shall be supported by adjustable steel hanger brackets connected to structural support by pairs of 3/8-inch (9.5 mm) diameter threaded rods.

    a. Exposed track soffit: Track soffit to be integral to track shape and shall be powder-coated off white paint finish. Track must accommodate termination of plenum sound barriers on both sides of track for maximum sound control.

2. Carriers: One trolley in alternating panels with 3-inch (76.2 mm) diameter glass reinforced nylon, all steel precision-ground ball-bearing wheels. Steel wheeled or reinforced polymer trolleys on aluminum track not permitted. Trolleys shall attach to panels with 1/2-inch (12.7 mm) diameter pendent bolt mounted to welded steel mounting plate.

2.7 OPTIONS

A. Pass Doors:

B. Single Pass Doors:

1. OP-01: Matching pass door same thickness

and appearance as the panels. ADAcompliant

pass door equipped with

friction latch and flush pulls for panic

operation. No threshold will be permitted.

C. Available accessories/options:

1. OP-01: Pocket Doors: Acousti-Seal Pocket Doors by Modernfold, Inc., with same construction, finish, and appearance as the adjacent panels.

    a. Pocket Door configuration shall be manually operated: Type III double doors hinged to a jamb on each side and closing in the center. One of the door panels is equipped with a smaller hinged panel that folds back when the operable partition is extended into the pocket.

PART 3: EXECUTION

3.1 INSTALLATION

A. General: Comply with ASTM E557, operable partition manufacturer's written installation instructions, Drawings and approved Shop Drawings.

B. Install operable partitions and accessories after other finishing operations, including painting have been completed.

C. Match operable partitions by installing panels from marked packages in numbered sequence indicated on Shop Drawings.

D. Broken, cracked, chipped, deformed or unmatched panels are not acceptable.

3.2 CLEANING AND PROTECTION

A. Clean partition surfaces upon completing installation of operable partitions to remove dust, dirt, adhesives, and other foreign materials according to manufacturer's written instructions.

B. Provide final protection and maintain conditions in a manner acceptable to the manufacturer and installer that ensure operable partitions are without damage or deterioration at time of Substantial Completion.

3.3 ADJUSTING

A. Adjust operable partitions to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Lubricate hardware and other moving parts.

3.4 EXAMINATION

A. Examine flooring, structural support, and opening, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of operable partitions. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 DEMONSTRATION

A. Demonstrate proper operation and maintenance procedures to Owner's representative.

B. Provide Operation and Maintenance Manual to Owner's representative.

SECTION 10 26 00

WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Wall and door protection at locations indicated on Drawings.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate <work results of this Section> with <other work>.

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.
2. Additional Attendees: <List Attendees>.
3. Additional Agenda Items:

a. <Agenda item>.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Show physical dimensions, features, anchorage details, rough-in measurement, and wall mounting brackets with mounted measurements.

B. Shop Drawings.

1. For each unit show locations, extent, details, and attachments to other work.
2. For units required to meet a design load, include structural analysis signed and sealed by a professional engineer meeting requirements specified in Section 01 40 00 "Quality Requirements."

C. Samples:

1. Corridor handrail and Corner guard: Two full sized samples. Approved samples may beincorporated into Work.

1.4 QUALITY ASSURANCE

A. Interior Fire Safety: ASTM E84.

B. Accessibility Requirements: Comply with applicable provisions in Department of Justice publication 2010 ADA Standards for Accessible Design and state accessibility code.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store units indoors, protected from elements.

a. Store at ambient temperature range recommended by manufacturer.

2. Handle units to prevent soiling and damage.

1.6 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.
2. Temperature: Maintain 70 degrees F for minimum 72 hours before installation.

B. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 WALL PROTECTION

A. Corridor Handrail: Preformed return to wall end caps, internal and external corners:

1. Manufacturers and Products:

a. American Floor Products Co., Inc.
b. Balco, Inc.
c. Construction Specialties, Inc.
d. IPC Door and Wall Protection Systems; Division of InPro Corporation.
e. Korogard Wall Protection Systems; a division of RJF International Corporation.
f. Kwalu, LLC.
g. Nystrom Building Products.
h. Pawling Corporation.
i. Tepromark International, Inc.
j. The R.C. Musson Rubber Company.
k. Wallguard.com.

2. Material: Formed steel with Wood finish.
3. Mounting: Surface
4. Projection From Wall to Outside of Rail: See Drawings. inch (mm)
5. Clear Space From Wall: See Drawingsinch (mm)
6. Length: Minimum one piece length not less than inches (mm); flush splicing.
7. Color: Architect selected.

B. Wood Handrails: Solid wood rail assemblies.

1. Manufacturers and Products:

a. American Floor Products Co., Inc.
b. Construction Specialties, Inc.
c. IPC Door and Wall Protection Systems; Division of InPro Corporation.
d. Korogard Wall Protection Systems; a division of RJF International Corporation.
e. Nystrom Building Products.
f. Pawling Corporation.

2. Rails:

a. Dimensions: See Drawings.
b. Species: See Drawings.
c. Finish: See Drawings.
d. Color: See Drawings or Architect selected.

3. Retainer: Extruded Aluminum.

a. Thickness: 0.0625 inch.
b. Finish: .

C. Flush MountedCorner Guards.

1. Material: Stainless steelwith extruded aluminumfull height retainer .
2. Projection From Wall to Outside of Guard: See Drawingsinch (mm)
3. Length: One piece.
4. Preformed end caps.
5. Color: Architect selected.

2.2 DOOR PROTECTION

A. Door Protection Systems: BHMA A156.6; rigid plastic plates and shapes for door impact protection.

1. Manufacturers and Products:

a. American Floor Products Co., Inc.
b. Construction Specialties, Inc.
c. IPC Door and Wall Protection Systems; Division of InPro Corporation.
d. Korogard Wall Protection Systems; a division of RJF International Corporation.
e. Kwalu, LLC.

f. Pawling Corporation.
g. Tepromark International, Inc.
h. Wallguard.com.

2. Material: Extruded rigid plastic:

a. Thickness: 0.040-inch (1.0-mm)
b. Size: See Drawings.
c. Door Edge Protection Shapes: See Drawings.
d. Door Frame Protection Height: See Drawings.
e. Mounting: Adhesive.
f. Color: Architect selected.

2.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide handrails capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform load of 50 lbf/ft. applied in any direction.
2. Concentrated load of 200 lbf applied in any direction.
3. Uniform and concentrated loads need not be assumed to act concurrently.

2.4 MATERIALS

A. Adhesives: Recommended by wall protection component manufacturer.

B. Solid Wood: Clear hardwood lumber of species indicated, free of appearance defects, and selected for compatible grain and color.

C. Mounting and Attachment Hardware: Non-corrosive metal screws, bolts, and other fasteners compatible with component and substrate.

2.5 FABRICATION

A. General: Factory assemble components to greatest extent possible to minimize field assembly.

B. Fabricate components with tight joints, corners and seams.

C. Miter corners and ends of wood handrails for returns.

2.6 FINISHES

A. Factory Finish

1. WoodHandrails: Type 304 stainless steel with No. finish. .

a. Color: See Drawings or Architect selected.

B. Factory Finish

1. Corner guards and Handrails: Satin chrome.Type 304 stainless steel with No. 4finish. Anodized and PVC.

a. Color: Architect selected.

C. Protect metal finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify wall conditions comply with manufacturer's instructions.

B. Install only after wall conditions meet installation requirements.

3.2 PREPARATION

A. Surface Preparation: Clean substrate before installation according to manufacturer's instructions.

3.3 INSTALLATION

A. Install wall and door protection.

B. Mounting Height from Finished Floor:

1. Rail: See Drawings.

C. Terminate handrails as directed by Architect.

D. Return rails to wall.Distance from door jamb as directed by Architect.

3.4 ERECTION TOLERANCES

A. Maximum Variation From Required Height for Horizontal Rails: 1/4inch (mm).

B. Maximum Variation From Level or Plane For Visible Length for Horizontal Rails: 1/4inch (mm).

3.5 CLEANING

A. Cleaning: Follow manufacturer's instructions.

END OF SECTION

SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Toilet Accessories
2. Laundry Accessories

B. Principal Products

1. Toilet Tissue Dispensers.
2. Paper Towel Dispenser and Waste Receptacles.
3. Grab bars.
4. Soap Dispenser.
5. Framed Mirrors
6. Sanitary Napkin Disposal
7. Toilet Seat Cover Dispenser

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate size and location of wall backing for support of accessories.

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Each type of accessory.
2. Initial selection color samples.

B. Schedules: Indicate product types, quantities, sizes, and installation locations. Use room numbers and accessory numbers in schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Instructions.

B. Special Procedure Submittals: <Describe Procedure>.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Manufacturer's recommended parts and quantities.

1. <Part Name: Quantity required>.

B. Tools: Manufacturer's recommended special tools required to maintain <Product>.

PART 2 - PRODUCTS

2.1 WASHROOM ACCESSORIES

A. Manufacturers and Products: See Toilet Accessory Schedule on Drawings.

2.2 PERFORMANCE

A. Accessibility Requirements: Comply with applicable provisions in Department of Justice publication 2010 ADA Standards for Accessible Design, ICC/ANSI A117.1, and state accessibility code.

B. Electrical Components:

1. UL Listed and labeled.
2. Sound Pressure Level: <Value> dBA, maximum, measured 3 feet from sound source.

2.3 MATERIALS

A. Stainless Steel: ASTM A480, Type 304, 0.031-inch minimum nominal thickness.

B. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.

C. Galvanized-Steel Sheet: ASTM A653/A653M, G60 hot-dip zinc coating.

D. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

E. Fasteners: Screws, bolts, and other devices, same material as accessory.

1. Exposed Fasteners: Tamper resistant.

F. Keys: Provide for locked accessories.

1. Locking: All accessories keyed alike.
2. Quantity: 2 minimum

G. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.4 FABRICATION

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.

1. Grind welded joints smooth.
2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify backing supports are in place before installing toilet accessories.

B. Powered Accessories: Verify electrical power is correctly located and is of proper characteristics.

3.2 INSTALLATION

A. Install accessories level, plumb, and firmly anchored.

B. Install using fasteners appropriate to substrate.

C. Grab Bars: Install to withstand 250 lbf minimum load, when tested per ASTM F446.

D. Powered Accessories: See Division 26 - Electrical for wiring requirements.

3.3 CLEANING AND PROTECTION

A. Clean exposed surfaces of compartments, hardware, and fittings using methods acceptable to the manufacturer.

B. Touch-up, repair or replace damaged products until Substantial Completion.

END OF SECTION

SECTION 11 30 13

RESIDENTIAL APPLIANCES AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Install Owner-furnished Residential appliances.
2. Furnish and Install Mailboxes.
3. Furnish and Install replacement Trash Chute Cover.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate casework shop drawings with proposed residential appliances and equipment.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Provide product data for Mailboxes and Trash Chute Cover.
2. Manufacturer's installation instructions.

B. Shop Drawings:

1. For Mailboxes and trash Chute Covers: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements:

1. Store residential appliances and equipment indoors, protected from elements and secured from theft.
2. Handle residential appliances and equipment to prevent damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND PRODUCTS

A. Owner Furnished Manufacturers and Products: See Equipment Schedule on Drawings.

B. Mailboxes

1. Manufacturer and Product: See Equipment Schedule on Drawings.

C. Replacement Trash Cute Cover

1. Manufacturer and Product: See Equipment Schedule on Drawings.

2.2 PERFORMANCE

A. Accessibility: Where residential appliances and equipment are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's Accessibility Guidelines and ICC/ANSI A117.1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utility services and electrical power match appliance requirements.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Set and adjust equipment level and plumb.

C. Connect appliances to utilities and make units operational.

D. Connect accessible unit range hood to remote wall switch to control hood fan and light operation.

E. Adjust appliances for smooth operation under loaded conditions.

3.3 PROTECTION

A. Protection: Protect installed appliances from damage caused by ongoing construction.

END OF SECTION

SECTION 12 36 00

COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Plastic laminate countertops.
2. Solid Surface countertops and front panels.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination Procedures:

1. Coordinate locations of utilities and accessories penetrating countertops.

B. Preinstallation Meeting Attendees and Procedures:

1. Conduct meeting one week, minimum, before starting Work of this Section.
2. Additional Attendees: <List Attendees>.
3. Additional Agenda Items:

a. <Agenda item>.

1.3 ACTION SUBMITTALS

A. Submittals - General:

1. Comply with AWI 100.

B. Product Data:

1. Countertop materials.
2. Adhesives.
3. Initial selection color samples.

C. Shop Drawings:

1. Dimensioned plans and elevations showing countertop locations.
2. Materials, profiles, assembly methods, joint details, fastening methods, sizes and locations of cutouts and finishes

D. Schedules:

E. Samples:

1. Plastic Laminates: 8 by 10 inches, minimum.
2. Solid Surface Material: 6 inches square.
3. Grommets: Each type and color.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements: Comply with AWI 200.

1.5 FIELD CONDITIONS

A. Ambient Conditions: Perform work within following limitations.

1. Building enclosed and environmental systems maintaining design conditions for Owner occupancy.

B. Existing Conditions: Verify field measurements before fabrication. Show field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 COUNTERTOP GENERAL REQUIREMENTS

A. Quality Standard: Comply with AWI 300 - Materials and ANSI AWI 620 - Installation for aesthetic grades.

B. Grade: Premium.

2.2 PLASTIC LAMINATE COUNTERTOPS

A. Grade: Custom.

B. HDPL Countertops: NEMA LD 3

1. Manufacturers and Products: See Finish Legend on Drawings.
2. Grade: HGS.
3. Grain and Pattern Direction: As directed by Architect to countertop.
4. Core Material: MDF.
5. Edge Treatment: See Drawings.
6. Backer Sheet: HPDL; NEMA LD 3, Grade BKL.

C. Installation Materials:

1. Adhesives: Recommended by laminate manufacturer.
2. Fasteners: Type, size, and material to suit each application.

2.3 SOLID SURFACE COUNTERTOPS

A. Solid Surface Countertops: IFSA 2-01, homogeneous resin sheets.

1. Manufacturers and Products: See Finish Schedule on Drawings.
2. Configuration: See Drawings.
3. Thickness: See drawings.

B. Installation Materials:

1. Adhesives: Recommended by countertop fabricator.
2. Fasteners: Type, size, and material to suit each application.

2.4 COUNTERTOP HARDWARE

A. Grommets: Plastic spring loaded cover and outer ring.

1. Manufacturers and Products: Review with Architect
2. Color: Architect selected.

B. Countertop Supports: Extruded aluminum Surface-mounted and Concealed T-brackets, L-shaped configuration.

1. Manufacturers and Products:

a. Rakks

2. Finish: Powder coat.

a. Color: Architect selected.

2.5 MATERIALS

A. Wood:

1. Fire-Retardant Treatment:

a. Chemically treated and pressure impregnated.
b. Flame Spread: 25, maximum per ASTM E84.
c. Label or otherwise identify fire retardant treated material.
d. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.

2.6 FABRICATION

A. Shop assemble work for delivery to site, permitting passage through building openings.

B. When necessary to cut and fit on site, fabricate materials with ample allowance for cutting. Furnish trim for scribing and site cutting.

C. Fabrication Tolerances:

1. Wood-Based and Solid-Surface Countertops: ANSI/AWI 0620, specified grade.

D. Finish exposed edges of countertops and back and end splashes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify adequacy of blocking, brackets, and fins to support countertops.

B. Verify location and sizes of utility rough-ins associated with countertops.

3.2 PREPARATION

A. Surface Preparation: Follow ANSI/AWI 0620.

B. Conditioning:

1. Acclimate products to installation environment per AWI 200 and ANSI/AWI 0620.

3.3 INSTALLATION

A. Follow ANSI/AWI 0620.

B. Installation Grade: Same as item being installed.

C. Cut openings for .

D. Install countertop fasteners in concealed locations.

E. Align edge surfaces. Provide supports to prevent deflection and lippage.

F. Interface with Other Work: Seal gaps between tops, splashes, and walls with mildew-resistant sealant specified in Section 07 92 00 - Joint Sealants.

3.4 CLEANING

A. Cleaning: Clean countertops and splashes; remove excess sealant from adjacent surfaces.

3.5 PROTECTION

A. Protection: Protect countertops from soil and damage during remainder of construction.

END OF SECTION

SECTION 12 48 13

ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Results

1. Recessed carpet mat and frame at main entrance vestibules.

B. Principal Products

1. Loose-laid carpet mat.

1.2 COORDINATION

A. Coordinate undercut of inner vestibule doors to clear the thickness of the entrance floor mat.

1.3 ACTION SUBMITTALS

A. Product Data: Manufacturer specifications and color selection information.

B. Samples: 12-inch square pieces of mat in selected color.

PART 2 - PRODUCTS

2.1 FLOOR MATS

A. Basis of Design:

1. Manufacturer and Product: See Finish Schedule on Drawings.
2. Color: Architect selected.
3. Comparable products of other manufacturers may be submitted for consideration.

B. Description:

1. Mat: Solution-dyed, UV-stabilized polypropylene fibers with high density rubber backing.
2. Frame: Extruded aluminum, clear anodized finish.

2.2 FABRICATION

A. Fabricate mats after frame installation in single unit sizes to fit within the entrance vestibule with 1/8 inch maximum space at frame.

PART 3 - EXECUTION

3.1 PREPARATION

A. Vacuum clean floor substrate.

3.2 INSTALLATION

A. Frames: Install frame sides in full contact with recess edges and fasteners that will be concealed after mat installation.

B. Loose lay mats in place shortly before inspection for Substantial Completion.

END OF SECTION

SECTION 12 93 00

SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY:

A. The work in this section includes fabrication and installation of the following items as shown on the Drawings and specified herein:
   1. Bicycle Rack
   2. Benches
   3. Chairs
   4. Litter Receptacle
   5. Ash Urn
   6. Grill

1.2 QUALITY ASSURANCE:

A. General: Submit in compliance with Standard Terms and Conditions, “Submittals.”

B. Product Data: Submit manufacturers specifications and installation instructions for all products specified herein.

C. Samples: Submit three samples for each type of finish indicated. Prepare samples on materials to be used in work. Where normal color and texture variations are to be expected, provide “range” samples showing limits of such variations.
   1. If requested, submit template for installation of fixtures to Architect.

D. LEED Submittals: Submit data on rapidly renewable materials (agricultural products harvested within a 10-year cycle), regionally manufactured materials (within 500 miles of the Project), regionally extracted, harvested, or recovered materials (within 500 miles), and recycled content (percentage by weight of constituents pre-consumer and post-consumer) as applicable to the product.

1.4 QUALITY ASSURANCE:

A. Installer: A single, pre-approved Contractor with a minimum of five years’ experience on comparable projects.

B. Codes and Standards: Comply with local governing regulations to assure legal placement of furnishings. Notify Architect immediately, and prior to installation, should a discrepancy exist.

C. Performance Requirements: Design and install the benches, brackets and attachments to sustain minimum 120 pound uniformly distributed load and 500 pound impact load applied in all directions at any location.

PART 2-PRODUCTS

1.4 MATERIALS:

A. BICYCLE RACK

1. Design is based upon Park-It Galvanized Plus 7-Bike Rack, SKU: 05CL1680 BARCO Products. Other manufacturer's products will be considered subject to meeting the performance criteria specified herein and as indicated on drawings. These racks shall stand 36" high and shall be 62.5" in length. They shall be fabricated from 1.9" x 0.095" wall in-line Galvanized Steel tube. The rack shall be outfitted with 3, 7G (3/16") Steel Plates the end plates will have three holes per base, the middle plate will have two holes per base in order to accommodate the anchor bolts. The base plates shall be full welded to the steel tube.
2. Bike Rack shall be embedded as shown on the drawings.
3. BARCO Products
   24 N. Washington Ave.
   Batavia, IL 60510
   1-800-338-2697
   Email sales@barcoproducts.com

B. BENCH

1. Design based upon Landscape Forms, Generation 50 Traditional Backed Bench with 2 Arms. Substitutions will not be considered. These benches stand 26" wide, 72" long and 33" high. They shall be fabricated from cast aluminum supports and a wood seating surface, waterproofed.
2. Type of wood to be determined by Landscape Architect.
3. Bench shall be surface mounted.
4. Landscape Forms Inc.
   431 Lawndale Avenue, Kalamazoo, Michigan 49048
   Local Rep. Jennifer Woods
   Phone 800-430-6206 x 1334
   email jenniferw@landscapeforms.com

C. CHAIR

1. Design based upon Landscape Forms, Windmark Chair with Arms. Substitutions will not be considered. These chairs stand 22.25" deep, 22.5" wide and 25.5" high. They shall be fabricated from steel supports and a wood seating surface, waterproofed.
2. Type of wood and color of powdercoating to be determined by Landscape Architect.
3. Chair shall be surface mounted.

4. Landscape Forms Inc.
   431 Lawndale Avenue, Kalamazoo, Michigan 49048
   Local Rep. Jennifer Woods

Phone 800-430-6206 x 1334
email jenniferw@landscapeforms.com

LITTER RECEPTACLE

1. Design based upon Landscape Forms, Generation 50 Litter Side Open. Substitutions will not be considered. These receptacles stand 23.25" diameter and 41" high. They shall be fabricated from wood panel slats, aluminum sheet metal and polyethylene base.
2. Receptacle shall be surface mounted.
3. Landscape Forms Inc.
   431 Lawndale Avenue, Kalamazoo, Michigan 49048
   Local Rep. Jennifer Woods
   Phone 800-430-6206 x 1334
   email jenniferw@landscapeforms.com

ASH URN

1. Design based upon Landscape Forms, Grenadier Ash Urn. Substitutions will not be considered. This ash urn is 10" in depth, 10" in width and 35" in height.
2. Receptacle shall be surface mounted and removable.
3. Color to be determined by Landscape Architect.
4. Landscape Forms Inc.
   431 Lawndale Avenue, Kalamazoo, Michigan 49048
   Local Rep. Jennifer Woods
   Phone 800-430-6206 x 1334
   email jenniferw@landscapeforms.com

GRILL

1. Design based upon Belson Outdoors, Universal Access Rotating Flip-Back Pedestal Grill, Model- G616H-3. Other manufacturer's products will be considered subject to meeting the performance criteria specified herein and as indicated on drawings. This grill is 14" in depth and 16" in length.
2. Grill shall be embedded.
3. Color flat black.
4. Belson Outdoors
   111 North River Road
   North Aurora, IL 60542
   Phone: 800.323.5664
   sales@belson.com

PART 3-EXECUTION

3.1 EXAMINATION:

A. Contractor must examine the areas and the conditions under which all items are to be installed and notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the contractor.

3.2 PREPARATION:

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages such as sleeves, concrete inserts, anchor bolts and miscellaneous items having integral anchor which are to be embedded in concrete or masonry. Coordinate delivery of such items to project site.

B. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay progress. Allow for adjustments during installation where taking field measurements before fabrication might delay work.

C. Layout: Prior to installation of furnishing of footings and other anchoring devices, accurately layout the site furnishings by marking locations with chalk, stakes or appropriate marking devices for the Architect's review. The Architect may, at his option, require the Contractor to layout the actual assembled furnishing on the site prior to installation.

D. Shop Assembly and Finish Work: To the extent possible, preassemble any items requiring assembly, and pre-finish any items requiring finishing, to minimize the work performed in the field.

3.3 INSTALLATION:

A. Fit exposed connections accurately together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installation of site furnishings. Set work accurately in location, alignment and elevation plumb, level, true, non-rocking and free of rack, measured from established lines and levels. Do not weld, cut, or abrade surfaces of components which have been coated or finished after fabrication, and are intended for field connection by mechanical means without further cutting or fitting.

C. Field Welding (if necessary): Comply with applicable AWS Specification for procedures of manual shielded metal-arc welding, for appearance and quality of welds made, and for methods used in correcting welding work. Weld connections which are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch up shop paint coat.

3.4 ADJUST AND CLEAN

A. Protect finishes of all items from damage during construction period by use of temporary protective coverings approved by manufacturers. Remove protective covering at project completion or when directed by Owner's Representative. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items which cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units as required.

B. Replacement: Remove from site and replace any furnishings which are nicked, broken, chipped, stained or otherwise damaged.

C. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint; and paint exposed areas with same material. Surface preparation, prime coat, and finish coat to be in accordance with manufacturer's instructions.

D. Protection: Protect furnishings from damage after installation until project is complete and accepted by owner.

END OF SECTION 12 93 00

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

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. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, 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.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

1.5 QUALITY ASSURANCE

A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

B. Performance criteria for specified equipment and materials shall take precedence over selected model numbers.

1.6 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 to prevent entrance of dirt, debris, and moisture.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. 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.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

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: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.

c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: 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.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

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: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Sioux Chief Manufacturing Co., Inc.
b. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: Compatible 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. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated Rough brass Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated Rough brass Polished chrome-plated and rough brass.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and equipment and make other design decisions. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. 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.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, cast-brass, chrome plated deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, cast brass type with spring clips.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces and Equipment Rooms: Split casting, cast-brass type with polished chrome-plated finish.
g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces and equipment rooms: Split-casting, cast-brass type with polished chrome-plated finish.
f. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas, plumbing wet-walls or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping rings.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 3 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping 4” and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and 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. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.10 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Escutcheons for Existing Piping:

1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with concealed exposed-rivet concealed hinge and spring clips.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish plate.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish plate.
5. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish casting, and set screw.
6. Bare Piping in Equipment Rooms: Split casting, cast brass plate, with set screw.
7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.11

3.12 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

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 01 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. Iron swing check valves.
5. Iron center guided check valves.
6. Iron gate valves.
7. Balancing Valves.
8. Drain Valves
9.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

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: 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 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.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

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.
2. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With valve stem extensions and the following features:

1. Gate Valves: With 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: Match pipe joining method

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. 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. Beeco.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Conbraco Industries, Inc.; Apollo Valves.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 200 psig minimum, match plans for greater pressures.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: SOLDER
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.
i. Port: Full.

2.3 BRONZE LIFT CHECK VALVES

A. Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: psig minimum, match plans for greater pressures.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: SOLDER
f. Disc: NBR, PTFE, or TFE.

2.4 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze or non-metallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.
b. Hammond Valve.
c. Kitz Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80
b. CWP Rating: 200 minimum, match plans for greater pressures.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.5 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Crane Co
   b. Hammond Valve.
   c. Kitz Corporation.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-71
   b. CWP Rating: 200 psig. minimum, match plans for greater pressures.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Match pipe system
   f. Trim: Bronze.

2.6 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Crane Co
   b. Hammond Valve.
   c. Kitz Corporation.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-125.
   b. CWP Rating: 200 psig. minimum, match plans for greater pressures.
   c. Body Material: ASTM A 126, gray iron.
   d. Style: Compact wafer.
   e. Seat: Bronze.

2.7 IRON GATE VALVES

A. OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Beeco.
    b. Hammond Valve.
    c. Crane Co.
    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-70
    b. CWP Rating: 200 psig minimum, match plans for greater pressures.
    c. Body Material: ASTM A 126, gray iron with bolted bonnet.
    d. Ends: Flanged.
    e. Trim: Bronze.
    f. Disc: Solid wedge.
    g. Packing and Gasket: Asbestos free.

2.8 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ITT Industries; Bell & Gossett Div.
    b. NIBCO INC.
    c. Taco, Inc.
    d. Watts Industries, Inc.; Water Products Div.

2. Type: Ball or globe valve with two readout ports and memory setting indicator.
3. Body: bronze.
4. Size: Same as connected piping
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.9 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 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.

B. Gate-Valve-Type, Hose-End Drain Valves

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

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 balancing valves in locations where they can easily be adjusted.

F. Install chainwheels on operators for gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. 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.

B. Set field-adjustable flow set points of balancing valves.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service:
    a. NPS 3 and smaller: Ball valve.
    b. NPS 4 and larger: OS&Y gate.
2. Throttling Service: Ball.
3. Sewage and sump basin discharge to have swing check valves with optional lever and weight or lever and spring, for quiet operation.

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 with the following end connections:

1. NPS 3 and smaller: Match the piping system joining method.
2. NPS 4 and larger: Flanged.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller: Bronze ball valves

B. Pipe NPS 4 and larger: OS&Y gate valves

3.6 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Bronze with threaded ends

B. Pipe NPS 3 and larger: Iron with flanged ends.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION 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. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 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 numbering scheme.

D. Valve Schedules: 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. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. 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.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation 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 full circumference of pipe.

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 1-1/2 inches.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Aluminum.
2. Stencil Paint: Exterior, gloss, alkyd enamel, colors as indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 2007 unless otherwise indicated.
    a. Exposed waste and vent to be stenciled with yellow letters on cast iron and black letters on galvanized and copper.
    b. Exposed storm piping to be stenciled with white letters on cast iron and black letters on galvanized and copper.

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 minimum thickness, and having predrilled or stamped 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.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 4 by 7 inches.
2. Fasteners: Brass grommet and wire Reinforced grommet and wire or string.
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. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting High-Performance Coatings."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles , complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. 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 **20 feet along each run. Reduce intervals to 10 feet** in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:

1. Low-Pressure, Compressed-Air Piping:

   a. Background Color: **White.**
   b. Letter Color: **Blue.**

2. Medium-Pressure, Compressed-Air Piping:

   a. Background Color: **White.**
   b. Letter Color: **Red.**

3. Domestic Water Piping:

   a. Background Color: **Blue**.
   b. Letter Color: **White.**

4. **Sanitary Waste and Storm Drainage** Piping:

   a. Background Color: **Black .**
   b. Letter Color: **Yellow**.

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.

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.
   c. Low-Pressure Compressed Air: **2 inches**, **square**.
   d. High-Pressure Compressed Air: **2 inches**, **square**.

2. Valve-Tag Color:

   a. Cold Water: **Blue**.
   b. Hot Water: **Red**.
   c. Low-Pressure Compressed Air: **White**.
   d. High-Pressure Compressed Air: **White**.

3. Letter Color:

   a. Cold Water: **White**.
   b. Hot Water: **White**.
   c. Low-Pressure Compressed Air: **Blue**.
   d. High-Pressure Compressed Air: **Red**.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 22 07 00

PLUMBING 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. Insulation Materials:
    a. Calcium silicate.
    b. Cellular glass.
    c. Flexible elastomeric.
    d. Mineral fiber.
    e. Phenolic.
    f. Polyisocyanurate.
    g. Polyolefin.
    h. Polystyrene.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

B. Related Sections include the following:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

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, flanges, valves, and specialties 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.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sample Sizes:

a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
b. Sheet Form Insulation Materials: 12 inches square.
c. Jacket Materials for Pipe: 12 inches long by NPS 2.
d. Sheet Jacket Materials: 12 inches square.
e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Qualification Data: For qualified Installer.

E. 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.

F. Field quality-control reports.

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.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

   a. One 10-foot section of NPS 2 straight pipe.
   b. One each of a 90-degree threaded, welded, and flanged elbow.
   c. One each of a threaded, welded, and flanged tee fitting.
   d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
   e. Four support hangers including hanger shield and insert.
   f. One threaded strainer and one flanged strainer with removable portion of insulation.
   g. One threaded reducer and one welded reducer.
   h. One pressure temperature tap.
   i. One mechanical coupling.

2. Equipment Mockups: One tank or vessel.

3. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
4. Notify Architect seven days in advance of dates and times when mockups will be constructed.
5. Obtain Architect's approval of mockups before starting insulation application.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed.

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.

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.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 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. Calcium Silicate:

1. Products: Subject to compliance with requirements, **provide one of the following**:

   a. Industrial Insulation Group (The); Thermo-12 Gold.
   b. Insert manufacturer's name; product name or designation.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory- Applied Jackets" Article.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Cell-U-Foam Corporation; Ultra-CUF.
b. Pittsburgh Corning Corporation; Foamglas Super K.
c. Insert manufacturer's name; product name or designation.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied **ASJ ASJ-SSL**: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
d. Insert manufacturer's name; product name or designation.

I. 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.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; All-Service Duct Wrap.
f. Insert manufacturer's name; product name or designation.

J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Johns Manville; HTB 23 Spin-Glas.

b. Owens Corning; High Temperature Flexible Batt Insulations.
c. Insert manufacturer's name; product name or designation.

K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation **without factory-applied jacket with factory-applied ASJ with factory-applied FSK jacket**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, **provide one of the following**:

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.
g. Insert manufacturer's name; product name or designation.

L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Fibrex Insulations Inc.; FBX.
b. Johns Manville; 1000 Series Spin-Glas.
c. Owens Corning; High Temperature Industrial Board Insulations.
d. Rock Wool Manufacturing Company; Delta Board.
e. Roxul Inc.; Roxul RW.
f. Thermafiber; Thermafiber Industrial Felt.
g. Insert manufacturer's name; product name or designation.

M. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000(Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
f. Insert manufacturer's name; product name or designation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, **without factory-applied jacket with factory-applied ASJ with factory-applied ASJ-SSL**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

N. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied **ASJ 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.

1. Products: Subject to compliance with requirements, **provide one of the following**:

    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.
    f. Insert manufacturer's name; product name or designation.

O. Phenolic:

1. Products: Subject to compliance with requirements, **provide one of the following**:

    a. Kingspan Corp.; Koolphen K.
    b. Insert manufacturer's name; product name or designation.

2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

    a. Preformed Pipe Insulation: **None ASJ**.
    b. Board for Equipment Applications: **None ASJ**.

P. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Products: Subject to compliance with requirements, **provide one of the following**:

    a. Apache Products Company; ISO-25.
    b. Dow Chemical Company (The); Trymer.
    c. Duna USA Inc.; Corafoam.
    d. Elliott Company; Elfoam.
    e. Insert manufacturer's name; product name or designation.

2. 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.
3. 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.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

a. Pipe Applications: **None ASJ ASJ-SSL PVDC PVDC-SSL**.
b. Equipment Applications: **None ASJ ASJ-SSL PVDC PVDC-SSL**.

Q. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Armacell LLC; Tubolit.
b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
c. RBX Corporation; Therma-cell.
d. Insert manufacturer's name; product name or designation.

R. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Dow Chemical Company (The); Styrofoam.
b. Knauf Insulation; Knauf Polystyrene.
c. Insert manufacturer's name; product name or designation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
c. Insert manufacturer's name; product name or designation.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.
b. Insert manufacturer's name; product name or designation.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, **provide one of the following**:

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.

d. Insert manufacturer's name; product name or designation.

2.3 ADHESIVES

A. 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.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Childers Products, Division of ITW; CP-97.
b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
c. Marathon Industries, Inc.; 290.
d. Mon-Eco Industries, Inc.; 22-30.
e. Vimasco Corporation; 760.
f. Insert manufacturer's name; product name or designation.

C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.
c. Insert manufacturer's name; product name or designation.

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, **provide one of the following**:

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.
e. Insert manufacturer's name; product name or designation.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, **provide one of the following**:

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.
e. Mon-Eco Industries, Inc.; 22-25.
f. Insert manufacturer's name; product name or designation.

F. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 97-13.
c. Insert manufacturer's name; product name or designation.

G. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, **provide one of the following**:

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.
e. Mon-Eco Industries, Inc.; 22-25.
f. Insert manufacturer's name; product name or designation.

H. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, **provide one of the following**:

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.
e. Speedline Corporation; Speedline Vinyl Adhesive.
f. Insert manufacturer's name; product name or designation.

2.4 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. Products: Subject to compliance with requirements, **provide one of the following**:

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. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.
g. Insert manufacturer's name; product name or designation.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, **provide one of the following**:

   a. Childers Products, Division of ITW; CP-30.
   b. Foster Products Corporation, H. B. Fuller Company; 30-35.
   c. ITW TACC, Division of Illinois Tool Works; CB-25.
   d. Marathon Industries, Inc.; 501.
   e. Mon-Eco Industries, Inc.; 55-10.
   f. Insert manufacturer's name; product name or designation.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, **provide one of the following**:

   a. Childers Products, Division of ITW; Encacel.
   b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
   c. Marathon Industries, Inc.; 570.
   d. Mon-Eco Industries, Inc.; 55-70.
   e. Insert manufacturer's name; product name or designation.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, **provide one of the following**:

   a. Childers Products, Division of ITW; CP-10.
   b. Foster Products Corporation, H. B. Fuller Company; 35-00.
   c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
   d. Marathon Industries, Inc.; 550.
   e. Mon-Eco Industries, Inc.; 55-50.
   f. Vimasco Corporation; WC-1/WC-5.
   g. Insert manufacturer's name; product name or designation.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, **provide one of the following**:

   a. Childers Products, Division of ITW; CP-52.
   b. Foster Products Corporation, H. B. Fuller Company; 81-42.
   c. Marathon Industries, Inc.; 130.
   d. Mon-Eco Industries, Inc.; 11-30.
   e. Vimasco Corporation; 136.
   f. Insert manufacturer's name; product name or designation.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, **provide one of the following**:

   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.
   f. Vimasco Corporation; 750.
   g. Insert manufacturer's name; product name or designation.

2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, **provide one of the following**:

   a. Childers Products, Division of ITW; CP-70.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
   f. Insert manufacturer's name; product name or designation.

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, **provide one of the following**:

   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
   f. Insert manufacturer's name; product name or designation.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, **provide one of the following**:

   a. Childers Products, Division of ITW; CP-76.
   b. Insert manufacturer's name; product name or designation.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 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.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

a. Products: Subject to compliance with requirements, **provide one of the following**:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
2) Insert manufacturer's name; product name or designation.

5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

a. Products: Subject to compliance with requirements, **provide one of the following**:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
2) Insert manufacturer's name; product name or designation.

6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

a. Products: Subject to compliance with requirements, **provide one of the following**:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
2) Insert manufacturer's name; product name or designation.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Vimasco Corporation; Elastafab 894.
b. Insert manufacturer's name; product name or designation.

B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Childers Products, Division of ITW; Chil-Glas No. 5.
b. Insert manufacturer's name; product name or designation.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for equipment and pipe.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.
c. Insert manufacturer's name; product name or designation.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.
b. Insert manufacturer's name; product name or designation.

2.10 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. Products: Subject to compliance with requirements, **provide one of the following**:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.
e. Insert manufacturer's name; product name or designation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: **White Color-code jackets based on system. Color as selected by Architect**.
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.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Childers Products, Division of ITW; Metal Jacketing Systems.
b. PABCO Metals Corporation; Surefit.
c. RPR Products, Inc.; Insul-Mate.
d. Insert manufacturer's name; product name or designation.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

    a. **Sheet and roll stock ready for shop or field sizing Factory cut and rolled to size**.
    b. 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 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick Polysurlyn**.
    d. Moisture Barrier for Outdoor Applications: **3-mil- thick, heat-bonded polyethylene and kraft paper 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.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

    a. **Sheet and roll stock ready for shop or field sizing Factory cut and rolled to size**.
    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 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick Polysurlyn**.
    d. Moisture Barrier for Outdoor Applications: **3-mil- thick, heat-bonded polyethylene and kraft paper 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.

D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Pittsburgh Corning Corporation; Pittwrap.
b. Polyguard; Insulrap No Torch 125.
c. Insert manufacturer's name; product name or designation.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, **provide one of the following**:

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.
e. Insert manufacturer's name; product name or designation.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. 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. Products: Subject to compliance with requirements, **provide one of the following**:

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.
e. Insert manufacturer's name; product name or designation.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. 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. Products: Subject to compliance with requirements, **provide one of the following**:

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.
e. Insert manufacturer's name; product name or designation.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.
e. Insert manufacturer's name; product name or designation.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
b. Insert manufacturer's name; product name or designation.

2. Width: 3 inches.
3. Film Thickness: **4 mils 6 mils** .
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, **provide one of the following**:

    a. Childers Products; Bands.
    b. PABCO Metals Corporation; Bands.
    c. RPR Products, Inc.; Bands.
    d. Insert manufacturer's name; product name or designation.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type **304 316 304 or Type 316**; 0.015 inch thick, **1/2 inch 3/4 inch** wide with **wing seal closed seal wing or closed seal**.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, **1/2 inch 3/4 inch** wide with **wing seal closed seal wing or closed seal**.
4. 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- 0.135-inch-** diameter shank, length to suit depth of insulation indicated.

    a. Products: Subject to compliance with requirements, **provide one of the following**:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; CD.
        3) Midwest Fasteners, Inc.; CD.
        4) Nelson Stud Welding; TPA, TPC, and TPS.
        5) Insert manufacturer's name; product name or designation.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, **0.106-inch- 0.135-inch-** diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon- steel washer.

    a. Products: Subject to compliance with requirements, **provide one of the following**:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; Cupped Head Weld Pin.
        3) Midwest Fasteners, Inc.; Cupped Head.
        4) Nelson Stud Welding; CHP.
        5) Insert manufacturer's name; product name or designation.

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. Products: Subject to compliance with requirements, **provide one of the following**:

        1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
        2) GEMCO; Perforated Base.

3) Midwest Fasteners, Inc.; Spindle.
4) Insert manufacturer's name; product name or designation.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: **Copper- or zinc-coated, low carbon steel Aluminum Stainless steel**, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. 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. Products: Subject to compliance with requirements, **provide one of the following**:

1) GEMCO; Nylon Hangers.
2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
3) Insert manufacturer's name; product name or designation.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. 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. Products: Subject to compliance with requirements, **provide one of the following**:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
2) GEMCO; Press and Peel.
3) Midwest Fasteners, Inc.; Self Stick.
4) Insert manufacturer's name; product name or designation.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: **Copper- or zinc-coated, low carbon steel Aluminum Stainless steel**, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, **galvanized-steel aluminum stainless-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. Products: Subject to compliance with requirements, **provide one of the following**:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.
5) Insert manufacturer's name; product name or designation.

b. 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.

a. Products: Subject to compliance with requirements, **provide one of the following**:

1) GEMCO.
2) Midwest Fasteners, Inc.
3) Insert manufacturer's name.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: **0.080-inch nickel-copper alloy 0.062-inch soft-annealed, stainless steel 0.062-inch soft-annealed, galvanized steel**.

1. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.
e. Insert manufacturer's name.

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. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. 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 **304 316 304 or 316**.

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. Surface Preparation: Clean and prepare surfaces to be insulated. 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.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. 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. 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. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **2 inches 4 inches** o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to 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 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 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 50 Insert percentage** 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 overcompress 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 prestressed 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 prestressed 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. Fabricate boxes from **galvanized steel aluminum stainless steel**, at least **0.040 inch 0.050 inch 0.060 inch** thick.
3. 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.

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. 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 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. 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 cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of 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 services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, 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 cut sections of cellular-glass block insulation of same thickness as pipe 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. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass 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.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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.

3.10 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 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.

3.11 PHENOLIC INSULATION INSTALLATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of 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 services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below ambient services, 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.

C. 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 cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
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.

3.12 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.

3.13 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 polyolefin 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 polyolefin 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 cut sections of polyolefin pipe and sheet 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.
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.

3.14 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands 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 polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation 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 section of polystyrene 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.

3.15 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. 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.

C. 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.

D. Where metal 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.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.16 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: **Two Insert number** 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.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: **Owner will engage Engage** a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. 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 Insert number** location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
2. 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 Insert number** locations of straight pipe, **three Insert number** locations of threaded fittings, **three Insert number** locations of welded fittings, **two Insert number** locations of threaded strainers, **two Insert number** locations of welded strainers, **three Insert number** locations of threaded valves, and **three Insert number** locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.18 DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation shall be **one of** the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and **3-lb/cu. ft. 6-lb/cu. ft.** nominal density.

B. Round, concealed breeching and connector insulation shall be **one of** the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and **3-lb/cu. ft. 6-lb/cu. ft.** nominal density.

C. Rectangular, exposed breeching and connector insulation shall be **one of** the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and **3-lb/cu. ft. 6-lb/cu. ft.** nominal density.

D. Rectangular, concealed breeching and connector insulation shall be **one of** the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and **3-lb/cu. ft. 6-lb/cu. ft.** nominal density.

3.19 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 is not factory insulated.

C. Heat-exchanger (water-to-water for domestic water heating service) insulation shall be **one of** the following:

1. Calcium Silicate: **3 inches Insert thickness** thick.
2. Cellular Glass: **3 inches Insert thickness** thick.
3. Mineral-Fiber Board: **2 inches Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
4. Mineral-Fiber Pipe and Tank: **2 inches Insert thickness** thick.

D. Steam-to-hot-water converter insulation shall be **one of** the following:

1. Calcium Silicate: **3 inches Insert thickness** thick.
2. Cellular Glass: **3 inches Insert thickness** thick.
3. Mineral-Fiber Board: **2 inches Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
4. Mineral-Fiber Pipe and Tank: **2 inches Insert thickness** thick.

E. Domestic water pump insulation shall be **one of** the following:

1. Cellular Glass: **2 inches Insert thickness** thick.
2. Mineral-Fiber Board: **1 inch Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
3. Phenolic: **1 inch Insert thickness** thick.
4. Polyisocyanurate: **1 inch Insert thickness** thick.

F. Domestic chilled-water (potable) pump insulation shall be **one of** the following:

1. Cellular Glass: **3 inches Insert thickness** thick.
2. Mineral-Fiber Board: **2 inches Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
3. Phenolic: **1 inch Insert thickness** thick.
4. Polyisocyanurate: **1-1/2 inches Insert thickness** thick.

G. Domestic hot-water pump insulation shall be **one of** the following:

1. Cellular Glass: **2 inches Insert thickness** thick.
2. Mineral-Fiber Board: **1 inch Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
3. Phenolic: **1 inch Insert thickness** thick.
4. Polyisocyanurate: **1 inch Insert thickness** thick.

H. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be **one of** the following:

1. Cellular Glass: **1-1/2 inches Insert thickness** thick.
2. Flexible Elastomeric: **1 inch Insert thickness** thick.
3. Mineral-Fiber Board: **1 inch Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
4. Mineral-Fiber Pipe and Tank: **1 inch Insert thickness** thick.
5. Phenolic: **1 inch Insert thickness** thick.
6. Polyisocyanurate: **1 inch Insert thickness** thick.
7. Polyolefin: **1 inch Insert thickness** thick.

I. Domestic hot-water storage tank insulation shall be **one of** the following:

1. Mineral-Fiber Board: **4 inches Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
2. Mineral-Fiber Pipe and Tank: **4 inches Insert thickness** thick.

J. Domestic water storage tank insulation shall be **one of** the following:

1. Cellular Glass: **2 inches Insert thickness** thick.
2. Flexible Elastomeric: **1 inch Insert thickness** thick.
3. Mineral-Fiber Board: **1 inch Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
4. Mineral-Fiber Pipe and Tank: **1 inch Insert thickness** thick.
5. Phenolic: **1 inch Insert thickness** thick.
6. Polyisocyanurate: **1 inch Insert thickness** thick.
7. Polyolefin: **1 inch Insert thickness** thick.

K. Domestic chilled-water (potable) storage tank insulation shall be **one of** the following:

1. Cellular Glass: **2 inches Insert thickness** thick.
2. Flexible Elastomeric: **1 inch Insert thickness** thick.
3. Mineral-Fiber Board: **1 inch Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
4. Mineral-Fiber Pipe and Tank: **1 inch Insert thickness** thick.

5. Phenolic: **1 inch Insert thickness** thick.
6. Polyisocyanurate: **1 inch Insert thickness** thick.
7. Polyolefin: **1 inch Insert thickness** thick.

L. Piping system filter-housing insulation shall be **one of** the following:

1. Cellular Glass: **3 inches Insert thickness** thick.
2. Mineral-Fiber Board: **2 inches Insert thickness** thick and **2-lb/cu. ft. 3-lb/cu. ft. 6-lb/cu. ft.** nominal density.
3. Mineral-Fiber Pipe and Tank: **2 inches Insert thickness** thick.

3.20 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.

3.21 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. **NPS 1 Insert pipe size** and Smaller: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **1/2 inch 3/4 inch 1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1/2 inch 1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **1/2 inch 3/4 inch 1 inch Insert thickness** thick.

2. **NPS 1-1/4 Insert pipe size** and Larger: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **1 inch Insert thickness** thick.

B. Domestic Hot and Recirculated Hot Water:

1. **NPS 1-1/4 Insert pipe size** and Smaller: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **3/4 inch 1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1/2 inch 1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **3/4 inch 1 inch Insert thickness** thick.

2. **NPS 1-1/2 Insert pipe size** and Larger: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **1 inch Insert thickness** thick.

C. Domestic Chilled Water (Potable):

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **1 inch Insert thickness** thick.

D. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **1 inch Insert thickness** thick.

E. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **1 inch Insert thickness** thick.

F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Flexible Elastomeric: **1/2 inch 3/4 inch 1 inch Insert thickness** thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1/2 inch 1 inch Insert thickness** thick.
c. Polyolefin: **1/2 inch 3/4 inch 1 inch Insert thickness** thick.

G. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **2 inches Insert thickness** thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1-1/2 inches Insert thickness** thick.
c. Phenolic: **1-1/2 inches Insert thickness** thick.
d. Polyisocyanurate: **1-1/2 inches Insert thickness** thick.

H. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **3/4 inch 1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1/2 inch 1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **3/4 inch 1 inch Insert thickness** thick.

I. Floor Drains, Traps, and Sanitary Drain Piping within **10 Feet Insert distance** of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **1-1/2 inches Insert thickness** thick.
b. Flexible Elastomeric: **3/4 inch 1 inch Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1/2 inch 1 inch Insert thickness** thick.
d. Phenolic: **1 inch Insert thickness** thick.
e. Polyisocyanurate: **1 inch Insert thickness** thick.
f. Polyolefin: **3/4 inch 1 inch Insert thickness** thick.

J. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Calcium Silicate: **1-1/2 inches Insert thickness** thick.

b. Cellular Glass: **1-1/2 inches Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: **1 inch Insert thickness** thick.

K. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Calcium Silicate: **1-1/2 inches Insert thickness** thick.
b. Cellular Glass: **1-1/2 inches Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: **1 inch Insert thickness** thick.

3.22 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **2 inches Insert thickness** thick.
b. Flexible Elastomeric: **2 inches Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **2 inches Insert thickness** thick.
d. Phenolic: **2 inches Insert thickness** thick.
e. Polyisocyanurate: **2 inches Insert thickness** thick.
f. Polyolefin: **2 inches Insert thickness** thick.
g. Polystyrene: **2 inches Insert thickness** thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **2 inches Insert thickness** thick.
b. Flexible Elastomeric: **2 inches Insert thickness** thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **2 inches Insert thickness** thick.
d. Phenolic: **2 inches Insert thickness** thick.
e. Polyisocyanurate: **2 inches Insert thickness** thick.
f. Polyolefin: **2 inches Insert thickness** thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be **one of** the following:

a. Cellular Glass: **2 inches Insert thickness** thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: **2 inches Insert thickness** thick.
c. Phenolic: **2 inches Insert thickness** thick.
d. Polyisocyanurate: **2 inches Insert thickness** thick.

D. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be **one of** the following:

    a. Calcium Silicate: **1-1/2 inches Insert thickness** thick.
    b. Cellular Glass: **1-1/2 inches Insert thickness** thick.
    c. Mineral-Fiber, Preformed Pipe Insulation, Type I: **1 inch Insert thickness** thick.

E. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be **one of** the following:

    a. Calcium Silicate: **1-1/2 inches Insert thickness** thick.
    b. Cellular Glass: **1-1/2 inches Insert thickness** thick.
    c. Mineral-Fiber, Preformed Pipe Insulation, Type II: **1 inch Insert thickness** thick.

3.23 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.

B. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, **2 inches Insert thickness** thick.

C. Chilled Water, All Sizes: Cellular glass, **2 inches Insert thickness** thick.

3.24 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. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. **PVC PVC, Color-Coded by System**: **20 mils 30 mils** thick.
3. Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch 0.040 inch** thick.
4. Painted Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch** thick.
5. Stainless Steel, Type **304 316 304 or 316**, **Smooth 2B Finish Corrugated Stucco Embossed**: **0.010 inch 0.016 inch 0.020 inch 0.024 inch** thick.
6. **Insert jacket type.**

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. None.
2. **PVC PVC, Color-Coded by System**: **20 mils 30 mils** thick.

3. Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch 0.040 inch** thick.
4. Painted Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch** thick.
5. Stainless Steel, Type **304 316 304 or 316**, **Smooth 2B Finish Corrugated Stucco Embossed**: **0.010 inch 0.016 inch 0.020 inch 0.024 inch** thick.
6. Insert jacket type.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. None.
2. **Painted** Aluminum, **Smooth Stucco Embossed** with **1-1/4-Inch- Deep Corrugations 2-1/2-Inch- Deep Corrugations 4-by-1-Inch Box Ribs**: **0.032 inch 0.040 inch** thick.
3. Stainless Steel, Type **304 316 304 or 316**, **Smooth Stucco Embossed**, with **1-1/4-Inch-Deep Corrugations 2-1/2-Inch- Deep Corrugations 4-by-1-Inch Box Ribs**: **0.020 inch 0.024 inch** thick.
4. Insert jacket type.

F. Piping, Concealed:

1. None.
2. **PVC PVC, Color-Coded by System**: **20 mils 30 mils** thick.
3. Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch 0.040 inch** thick.
4. Painted Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch** thick.
5. Stainless Steel, Type **304 316 304 or 316**, **Smooth 2B Finish Corrugated Stucco Embossed**: **0.010 inch 0.016 inch 0.020 inch 0.024 inch** thick.
6. Insert jacket type.

G. Piping, Exposed:

1. None.
2. **PVC PVC, Color-Coded by System**: **20 mils 30 mils** thick.
3. Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch 0.040 inch** thick.
4. Painted Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch** thick.
5. Stainless Steel, Type **304 316 304 or 316**, **Smooth 2B Finish Corrugated Stucco Embossed**: **0.010 inch 0.016 inch 0.020 inch 0.024 inch** thick.
6. Insert jacket type.

3.25 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. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. **PVC PVC, Color-Coded by System**: **20 mils 30 mils** thick.
3. Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch 0.040 inch** thick.
4. Painted Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch** thick.
5. Stainless Steel, Type **304 316 304 or 316**, **Smooth 2B Finish Corrugated Stucco Embossed**: **0.010 inch 0.016 inch 0.020 inch 0.024 inch** thick.
6. **Insert jacket type.**

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. **Painted** Aluminum, **Smooth Corrugated Stucco Embossed with Z-Shaped Locking Seam**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch 0.040 inch** thick.
2. Stainless Steel, Type **304 316 304 or 316**, **Smooth 2B Finish Corrugated Stucco Embossed with Z-Shaped Locking Seam**: **0.010 inch 0.016 inch 0.020 inch 0.024 inch** thick.
3. **Insert jacket type.**

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. **Painted** Aluminum, **Smooth Stucco Embossed** with **1-1/4-Inch- Deep Corrugations 2-1/2-Inch- Deep Corrugations 4-by-1-Inch Box Ribs**: **0.032 inch 0.040 inch** thick.
2. Stainless Steel, Type **304 316 304 or 316**, **Smooth Stucco Embossed**, with **1-1/4-Inch-Deep Corrugations 2-1/2-Inch- Deep Corrugations 4-by-1-Inch Box Ribs**: **0.020 inch 0.024 inch** thick.
3. **Insert jacket type.**

F. Piping, Concealed:

1. None.
2. **PVC PVC, Color-Coded by System**: **20 mils 30 mils** thick.
3. Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch 0.040 inch** thick.
4. Painted Aluminum, **Smooth Corrugated Stucco Embossed**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch** thick.
5. Stainless Steel, Type **304 316 304 or 316**, **Smooth 2B Finish Corrugated Stucco Embossed**: **0.010 inch 0.016 inch 0.020 inch 0.024 inch** thick.
6. **Insert jacket type.**

G. Piping, Exposed:

1. PVC: **20 mils 30 mils 40 mils** thick.
2. **Painted** Aluminum, **Smooth Corrugated Stucco Embossed with Z-Shaped Locking Seam**: **0.016 inch 0.020 inch 0.024 inch 0.032 inch 0.040 inch** thick.

3. Stainless Steel, Type **304 316 304 or 316**, **Smooth 2B Finish Corrugated Stucco Embossed with Z-Shaped Locking Seam**: **0.010 inch 0.016 inch 0.020 inch 0.024 inch** thick.
4. **Insert jacket type.**

3.26 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

1. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER 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. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Flexible connectors.

B. Related Section:

1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

2. Division 22 Section “Common Work Results for Plumbing”.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to SEI/ASCE 7.

1.4 SUBMITTALS

A. Product Data: For the following products:

1. Transition fittings.
2. Dielectric fittings.
3. Flexible connectors.

B. Water Samples: Specified in "Cleaning" Article.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Architect and Construction Manager Owner no fewer than five days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Architect's and Construction Manager's written permission.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM 88, Type K and ASTM B 88, Type L water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.

2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

4. 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.

5. Copper Pressure-Seal-Joint Fittings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Elkhart Products Corporation; Industrial Division.
2) NIBCO INC.
3) Viega; Plumbing and Heating Systems.

b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

6. Grooved-Joint Copper-Tube Appurtenances:

a. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.

2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. 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. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.

a. Gaskets: AWWA C111, rubber.

2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.

a. Gaskets: AWWA C111, rubber.

C. Plain-End, Ductile-Iron Pipe: AWWA C151.

1. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Anvil International.
2) Victaulic Company.

b. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

c. Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E Grade B, Standard Weight. Include ends matching joining method.

1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.

2. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

3. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.

4. Flanges: ASME B16.1, Class 125, cast iron.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-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/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

E. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

F. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.6 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Tube.

C. Material: LLDPE film of 0.008-inch minimum thickness.

D. Color: Black or Natural color.

2.7 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cascade Waterworks Manufacturing.
b. Dresser, Inc.; Dresser Piping Specialties.
c. Ford Meter Box Company, Inc. (The).
d. JCM Industries.
e. Romac Industries, Inc.
f. Smith-Blair, Inc; a Sensus company.
g. Viking Johnson; c/o Mueller Co.

2.8 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. EPCO Sales, Inc.
    d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

1. Description:

    a. Factory-fabricated, bolted, companion-flange assembly.

    b. Pressure Rating: 150 psig 175 psig minimum 300 psig.
    c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.

2. Description:

    a. Nonconducting materials for field assembly of companion flanges.
    b. Pressure Rating: 150 psig Insert pressure.
    c. Gasket: Neoprene or phenolic.
    d. Bolt Sleeves: Phenolic or polyethylene.
    e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Calpico, Inc.
    b. Lochinvar Corporation.

2. Description:

    a. Galvanized-steel coupling.
    b. Pressure Rating: 300 psig at 225 deg F.
    c. End Connections: Female threaded.
    d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Perfection Corporation; a subsidiary of American Meter Company.
    b. Precision Plumbing Products, Inc.
    c. Victaulic Company.

2. Description:

    a. Electroplated steel nipple complying with ASTM F 1545.
    b. Pressure Rating: 300 psig at 225 deg F.
    c. End Connections: Male threaded or grooved.
    d. Lining: Inert and noncorrosive, propylene.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Flex Pression, Ltd.
4. Flex-Weld, Inc.
5. Hyspan Precision Products, Inc.
6. Mercer Rubber Co.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. Tozen Corporation.
10. Unaflex, Inc.
11. Universal Metal Hose; a Hyspan company

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 250 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 250 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.10 SLEEVES

A. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel-Pipe: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, with plain ends.

C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.11 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe 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, with corrosion-resistant coating.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.12 WALL PENETRATION SYSTEMS

A. Available Manufacturers : Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or equal:

1. SIGMA.

B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.

1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
3. Housing-to-Sleeve Gasket: EPDM rubber.
4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
5. Pipe Sleeve: AWWA C151, ductile-iron pipe or ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. 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.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

G. Install domestic water piping level without pitch and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. 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.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping adjacent to equipment and specialties to allow service and maintenance.

M. Install piping to permit valve servicing.

N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

O. Install piping free of sags and bends.

P. Install fittings for changes in direction and branch connections.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

S. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

3.3 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 pipes, tubes, and fittings before assembly.

C. 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.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.
2. NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 Insert pipe size and Smaller: Use dielectric couplings or nipples unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges flange kits nipples.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

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; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet 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. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
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 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals wall penetration systems specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.

    a. Extend sleeves 2 inches above finished floor level.
    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

    a. Steel pipe sleeves for pipes smaller than NPS 6.
    b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
    c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
5. Sleeves for Piping Passing through Exterior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.

b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
d. Do not use sleeves when wall penetration systems are used.

6. Sleeves for Piping Passing through Interior Concrete Walls:

a. Steel pipe sleeves for pipes smaller than NPS 6.
b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.

L. 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 in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.9 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.10 WALL PENETRATION SYSTEM INSTALLATION

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

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 one day 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 tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

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 a 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 for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 ADJUSTING

A. 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 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.

3.14 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures 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. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 PIPING SCHEDULE

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 and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water, building service piping, NPS 2 and smaller, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K; coper solder-joint fittings; and brazed copper pressure-seal fittings joints.

2. Mechanical-joint, ductile-iron pipe; standard- or compact- pattern mechanical-joint fittings; and mechanical joints.

D. Under-building-slab, domestic water piping, NPS 3 and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type L; no joints allowed below grade.

E. Aboveground domestic water piping, NPS 3 and smaller shall be the following:

1. Hard copper tube, ASTM B 88, Type L cast- copper solder-joint fittings; and soldered joints.

2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

F. Aboveground domestic water piping, NPS 3-1/2 and larger, shall be the following:
1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING 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. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Temperature-actuated water mixing valves.
5. Strainers.
6. Outlet boxes.
7. Hose stations.
8. Hose bibbs.
9. Wall hydrants.
10. Ground hydrants.
11. Post hydrants.
12. Water hammer arresters.
13. Air vents.
14. Trap-seal primer valves.
15. Trap-seal primer systems.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages For Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.
3. Division 22 Section "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Division 22 Section "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
6. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: **125 psig Insert pressure**, unless otherwise indicated.

1.4 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.

1.5 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. 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."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ames Co.
b. Cash Acme.
c. Conbraco Industries, Inc.
d. FEBCO; SPX Valves & Controls.
e. Rain Bird Corporation.
f. Toro Company (The); Irrigation Div.
g. Watts Industries, Inc.; Water Products Div.
h. Zurn Plumbing Products Group; Wilkins Div.

i. Insert manufacturer's name.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: **Rough bronze Chrome plated**.

B. Hose-Connection Vacuum Breakers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Arrowhead Brass Products, Inc.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Legend Valve.
   e. MIFAB, Inc.
   f. Prier Products, Inc.
   g. Watts Industries, Inc.; Water Products Div.
   h. Woodford Manufacturing Company.
   i. Zurn Plumbing Products Group; Light Commercial Operation.
   j. Zurn Plumbing Products Group; Wilkins Div.
   k. Insert manufacturer's name.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: **Chrome or nickel plated Rough bronze**.

C. Pressure Vacuum Breakers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Toro Company (The); Irrigation Div.
   f. Watts Industries, Inc.; Water Products Div.
   g. Zurn Plumbing Products Group; Wilkins Div.
   h. Insert manufacturer's name.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: **5 psig Insert pressure** maximum, through middle 1/3 of flow range.
5. Size: **Insert NPS.**
6. Design Flow Rate: **Insert gpm.**

7. Selected Unit Flow Range Limits: **Insert gpm.**
8. Pressure Loss at Design Flow Rate: **Insert psig.**
9. Accessories:

a. Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. Watts Industries, Inc.; Water Products Div.
c. Woodford Manufacturing Company.
d. Zurn Plumbing Products Group; Wilkins Div.
e. Insert manufacturer's name.

2. Standard: ASSE 1035.
3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.
b. Watts Industries, Inc.; Water Products Div.
c. Insert manufacturer's name.

2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Size: **NPS 1/4 NPS 3/8 NPS 1/2 NPS 3/4 NPS 1**.
5. Accessories:

a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cash Acme.

b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Honeywell Water Controls.
e. Legend Valve.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Plumbing Products Group; Wilkins Div.
h. Insert manufacturer's name.

2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: **NPS 1/2 NPS 3/4**.
5. Body: Bronze.
6. End Connections: **Union, solder Solder** joint.
7. Finish: **Chrome plated Rough bronze**.

B. Reduced-Pressure-Principle Backflow Preventers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ames Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Flomatic Corporation.
e. Watts Industries, Inc.; Water Products Div.
f. Zurn Plumbing Products Group; Wilkins Div.
g. Insert manufacturer's name.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: **12 psig Insert pressure** maximum, through middle 1/3 of flow range.
5. Size: **Insert NPS.**
6. Design Flow Rate: **Insert gpm.**
7. Selected Unit Flow Range Limits: **Insert gpm.**
8. Pressure Loss at Design Flow Rate: **Insert psig** for sizes NPS 2 and smaller; **Insert psig** for NPS 2-1/2 and larger.
9. Body: Bronze for NPS 2 and smaller; **cast iron with interior lining complying with AWWA C550 or that is FDA approved steel with interior lining complying with AWWA C550 or that is FDA approved stainless steel** for NPS 2-1/2 and larger.
10. End Connections: Threaded for NPS 2 and smaller; **flanged Insert type** for NPS 2-1/2 and larger.
11. Configuration: Designed for **horizontal, straight through vertical inlet, horizontal center section, and vertical outlet vertical Insert configuration** flow.
12. Accessories:

a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2- 1/2 and larger.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check Backflow-Prevention Assemblies **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ames Co.
    b. Conbraco Industries, Inc.
    c. FEBCO; SPX Valves & Controls.
    d. Flomatic Corporation.
    e. Watts Industries, Inc.; Water Products Div.
    f. Zurn Plumbing Products Group; Wilkins Div.
    g. Insert manufacturer's name.

2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: **5 psig Insert pressure** maximum, through middle 1/3 of flow range.
5. Size: **Insert NPS.**
6. Design Flow Rate: **Insert gpm.**
7. Selected Unit Flow Range Limits: **Insert gpm.**
8. Pressure Loss at Design Flow Rate: **Insert psig** for sizes NPS 2 and smaller; **Insert psig** for NPS 2-1/2 and larger.
9. Body: Bronze for NPS 2 and smaller; **cast iron with interior lining complying with AWWA C550 or that is FDA approved steel with interior lining complying with AWWA C550 or that is FDA approved stainless steel** for NPS 2-1/2 and larger.
10. End Connections: Threaded for NPS 2 and smaller; **flanged Insert type** for NPS 2-1/2 and larger.
11. Configuration: Designed for **horizontal, straight through Insert configuration** flow.
12. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2- 1/2 and larger.

D. Beverage-Dispensing-Equipment Backflow Preventers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. Watts Industries, Inc.; Water Products Div.
    c. Zurn Plumbing Products Group; Wilkins Div.
    d. Insert manufacturer's name.

2. Standard: ASSE 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.
6. End Connections: Threaded.

E. Dual-Check-Valve Backflow Preventers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Cash Acme.
    b. Conbraco Industries, Inc.
    c. FEBCO; SPX Valves & Controls.
    d. Flomatic Corporation.
    e. Ford Meter Box Company, Inc. (The).
    f. Honeywell Water Controls.
    g. Legend Valve.
    h. McDonald, A. Y. Mfg. Co.
    i. Mueller Co.; Water Products Div.
    j. Watts Industries, Inc.; Water Products Div.
    k. Zurn Plumbing Products Group; Wilkins Div.
    l. Insert manufacturer's name.

2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Size: **NPS 1/2 NPS 3/4 NPS 1 NPS 1-1/4**.
5. Body: Bronze with union inlet.

F. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Cash Acme.
    b. Lancer Corporation.
    c. Watts Industries, Inc.; Water Products Div.
    d. Insert manufacturer's name.

2. Standard: ASSE 1032.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.
6. End Connections: Threaded.

G. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ames Co.
    b. Conbraco Industries, Inc.

c. FEBCO; SPX Valves & Controls.
d. Watts Industries, Inc.; Water Products Div.
e. Zurn Plumbing Products Group; Wilkins Div.
f. Insert manufacturer's name.

2. Standard: ASSE 1047 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: **12 psig Insert pressure** maximum, through middle 1/3 of flow range.
5. Size: **Insert NPS.**
6. Design Flow Rate: **Insert gpm.**
7. Selected Unit Flow Range Limits: **Insert gpm.**
8. Pressure Loss at Design Flow Rate: **Insert psig.**
9. Body: **Cast iron with interior lining complying with AWWA C550 or that is FDA approved Steel with interior lining complying with AWWA C550 or that is FDA approved Stainless steel**.
10. End Connections: Flanged.
11. Configuration: Designed for **horizontal, straight through vertical inlet, horizontal center section, and vertical outlet vertical Insert configuration** flow.
12. Accessories:

a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

H. Double-Check, Detector-Assembly Backflow Preventers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ames Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Watts Industries, Inc.; Water Products Div.
e. Zurn Plumbing Products Group; Wilkins Div.
f. Insert manufacturer's name.

2. Standard: ASSE 1048 and FMG approved or UL listed.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: **5 psig Insert pressure** maximum, through middle 1/3 of flow range.
5. Size: **Insert NPS.**
6. Design Flow Rate: **Insert gpm.**
7. Selected Unit Flow Range Limits: **Insert gpm.**
8. Pressure Loss at Design Flow Rate: **Insert psig.**
9. Body: **Cast iron with interior lining complying with AWWA C550 or that is FDA approved Steel with interior lining complying with AWWA C550 or that is FDA approved Stainless steel**.
10. End Connections: Flanged.

11. Configuration: Designed for **horizontal, straight through vertical inlet, horizontal center section, and vertical outlet vertical Insert configuration** flow.
12. Accessories:

    a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
    b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

I. Hose-Connection Backflow Preventers **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. Watts Industries, Inc.; Water Products Div.
    c. Woodford Manufacturing Company.
    d. Insert manufacturer's name.

2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

J. Backflow-Preventer Test Kits **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. FEBCO; SPX Valves & Controls.
    c. Flomatic Corporation.
    d. Watts Industries, Inc.; Water Products Div.
    e. Zurn Plumbing Products Group; Wilkins Div.
    f. Insert manufacturer's name.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators **Insert drawing designation if any**:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Cash Acme.
    b. Conbraco Industries, Inc.
    c. Honeywell Water Controls.

d. Watts Industries, Inc.; Water Products Div.
e. Zurn Plumbing Products Group; Wilkins Div.
f. Insert manufacturer's name.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: **Insert NPS.**
5. Design Flow Rate: **Insert gpm.**
6. Design Inlet Pressure: **Insert psig.**
7. Design Outlet Pressure Setting: **Insert psig.**
8. Body: Bronze **with chrome-plated finish** for NPS 2 and smaller; cast iron **with interior lining complying with AWWA C550 or that is FDA approved** for NPS 2-1/2 and NPS 3.
9. Valves for Booster Heater Water Supply: Include integral bypass.
10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water Control Valves **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CLA-VAL Automatic Control Valves.
b. Flomatic Corporation.
c. OCV Control Valves.
d. Watts Industries, Inc.; Ames Fluid Control Systems.
e. Watts Industries, Inc.; Watts ACV.
f. Zurn Plumbing Products Group; Wilkins Div.
g. Insert manufacturer's name.

2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

a. Size: **Insert NPS.**
b. Pattern: **Angle Globe**-valve design.
c. Trim: Stainless steel.

5. Design Flow: **Insert gpm.**
6. Design Inlet Pressure: **Insert psig.**
7. Design Outlet Pressure Setting: **Insert psig.**
8. End Connections: Threaded for NPS 2 and smaller; **flanged Insert type** for NPS 2-1/2 and larger.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.
    b. Cash Acme.
    c. Conbraco Industries, Inc.
    d. Honeywell Water Controls.
    e. Legend Valve.
    f. Leonard Valve Company.
    g. Powers; a Watts Industries Co.
    h. Symmons Industries, Inc.
    i. Taco, Inc.
    j. Watts Industries, Inc.; Water Products Div.
    k. Zurn Plumbing Products Group; Wilkins Div.
    l. Insert manufacturer's name.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded **union** inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: **Insert deg F.**
9. Tempered-Water Design Flow Rate: **Insert gpm.**
10. Valve Finish: **Chrome plated Rough bronze**.

B. Primary, Thermostatic, Water Mixing Valves **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.
    b. Lawler Manufacturing Company, Inc.
    c. Leonard Valve Company.
    d. Powers; a Watts Industries Co.
    e. Symmons Industries, Inc.
    f. Insert manufacturer's name.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: **Exposed-mounting Cabinet-type**, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded **union** inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.

9. Tempered-Water Setting: **Insert deg F.**
10. Tempered-Water Design Flow Rate: **Insert gpm.**
11. Selected Valve Flow Rate at 45-psig Pressure Drop: **Insert gpm.**
12. Pressure Drop at Design Flow Rate: **Insert psig.**
13. Valve Finish: **Chrome plated Polished, chrome plated Rough bronze**.
14. Piping Finish: **Chrome plated Copper**.
15. Cabinet: Factory-fabricated, stainless steel, for **recessed surface** mounting and with hinged, stainless-steel door.

C. Manifold, Thermostatic, Water-Mixing-Valve Assemblies **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Leonard Valve Company.
   b. Powers; a Watts Industries Co.
   c. Symmons Industries, Inc.
   d. Insert manufacturer's name.

2. Description: Factory-fabricated, **cabinet-type exposed-mounting**, thermostatically controlled, water-mixing-valve assembly in **two three**-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
4. Intermediate-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
5. Small-Flow Parallel: Thermostatic water mixing valve.
6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
8. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.
9. Cabinet: Factory-fabricated, stainless steel, for **recessed surface** mounting and with hinged, stainless-steel door.
10. Selected Large Flow, Tempered Water Valve Size: **Insert size.**
11. Tempered-Water Setting: **Insert deg F.**
12. Unit Tempered-Water Design Flow Rate: **Insert gpm.**
13. Unit Minimum Tempered-Water Design Flow Rate: **Insert gpm.**
14. Selected Unit Flow Rate at 45-psig Pressure Drop: **Insert gpm.**
15. Unit Pressure Drop at Design Flow Rate: **Insert psig.**
16. Unit Tempered-Water Outlet Size: **Insert NPS** end connection.
17. Unit Hot- and Cold-Water Inlet Size: **Insert NPS** end connections.
18. Thermostatic Mixing Valve and Water Regulator Finish: **Chrome plated Polished, chrome plated Rough bronze**.
19. Piping Finish: **Chrome plated Copper**.

D. Photographic-Process, Thermostatic, Water-Mixing-Valve Assemblies **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Lawler Manufacturing Company, Inc.
    b. Leonard Valve Company.
    c. Powers; a Watts Industries Co.
    d. Symmons Industries, Inc.
    e. Insert manufacturer's name.

2. Standard: ASSE 1017, thermostatically controlled water mixing valve made for precise, process-water temperature control.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze with corrosion-resistant interior components.
5. Connections: Threaded inlets and outlet.
6. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, thermometer, shutoff valve, and adjustable, temperature-control handle.
7. Cabinet: Factory-fabricated, stainless steel, for surface mounting; with controls and thermometer mounted on front.
8. Tempered-Water Setting: **Insert deg F.**
9. Tempered-Water Design Flow Rate: **Insert gpm.**
10. Tempered-Water Outlet Size: **Insert NPS** end connection.
11. Hot- and Cold-Water Inlet Size: **Insert NPS** end connections.

E. Individual-Fixture, Water Tempering Valves **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Cash Acme.
    b. Conbraco Industries, Inc.
    c. Honeywell Water Controls.
    d. Lawler Manufacturing Company, Inc.
    e. Leonard Valve Company.
    f. Powers; a Watts Industries Co.
    g. Watts Industries, Inc.; Water Products Div.
    h. Zurn Plumbing Products Group; Wilkins Div.
    i. Insert manufacturer's name.

2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: **Insert deg F.**
9. Tempered-Water Design Flow Rate: **Insert gpm.**

F. Primary Water Tempering Valves **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Heat-Timer Corporation.
    b. Holby Valve Co., Inc.
    c. Insert manufacturer's name.

2. Standard: ASSE 1017, thermostatically controlled tempering valve, listed as tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze.
5. Temperature Control: Manual.
6. Inlets and Outlet: Threaded.
7. Selected Primary Water Tempering Valve Size: **Insert size.**
8. Tempered-Water Setting: **Insert deg F.**
9. Tempered-Water Design Flow Rate: **Insert gpm.**
10. Pressure Drop at Design Flow Rate: **Insert psig.**
11. Tempered-Water Outlet Size: **Insert NPS** end connection.
12. Cold-Water Inlet Size: **Insert NPS** end connection.
13. Hot-Water Inlet Size: **Insert NPS** end connection.
14. Valve Finish: **Rough bronze Insert finish**.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers **Insert drawing designation if any**:

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. StrainersNPS 2 and Smaller: **0.020 inch 0.033 inch 0.062 inch Insert size**.
    b. Strainers NPS 2-1/2 to NPS 4: **0.045 inch 0.062 inch 0.125 inch Insert size**.
    c. Strainers NPS 5 and Larger: **0.10 inch 0.125 inch 0.25 inch Insert size**.

6. Drain: **Pipe plug Factory-installed, hose-end drain valve**.

2.6 OUTLET BOXES

A. Clothes Washer Outlet Boxes **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Acorn Engineering Company.
    b. Guy Gray Manufacturing Co., Inc.

c. IPS Corporation.
d. LSP Products Group, Inc.
e. Oatey.
f. Plastic Oddities; a division of Diverse Corporate Technologies.
g. Symmons Industries, Inc.
h. Watts Industries, Inc.; Water Products Div.
i. Whitehall Manufacturing; a div. of Acorn Engineering Company.
j. Zurn Plumbing Products Group; Light Commercial Operation.
k. Insert manufacturer's name.

2. Mounting: Recessed.
3. Material and Finish: **Enameled-steel or epoxy-painted-steel Enameled-steel or epoxy-painted-steel or plastic Plastic Stainless-steel** box and faceplate.
4. 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.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: **NPS 1-1/2 NPS 2** standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Engineering Company.
b. IPS Corporation.
c. LSP Products Group, Inc.
d. Oatey.
e. Plastic Oddities; a division of Diverse Corporate Technologies.
f. Insert manufacturer's name.

2. Mounting: Recessed.
3. Material and Finish: **Enameled-steel or epoxy-painted-steel Enameled-steel or epoxy-painted-steel or plastic Plastic Stainless-steel** box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.7 HOSE STATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARCHON Industries, Inc.
2. Armstrong International, Inc.
3. Cooney Brothers, Inc.
4. DynaFluid Ltd.
5. Leonard Valve Company.
6. Strahman Valves, Inc.
7. T & S Brass and Bronze Works, Inc.
8. **Insert manufacturer's name.**

B. Single-Temperature-Water Hose Stations **Insert drawing designation if any**:

1. Standard: ASME A112.18.1.
2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
3. Hose-Rack Material: Stainless steel.
4. Body Material: Bronze **with stainless-steel wetted parts**.
5. Body Finish: Rough bronze**, chrome plated**.
6. Mounting: **Wall, with reinforcement Floor, with stainless-steel pedestal**.
7. Supply Fitting: **NPS 1/2 NPS 3/4** gate, globe, or ball valve and check valve and **NPS 1/2 NPS 3/4** copper, water tubing. Omit check valve if check stop is included with fitting.
8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; **25 feet 50 feet Insert length** long.
9. Nozzle: With hand squeeze on-off control.
10. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

C. Hot- and Cold-Water Hose Stations **Insert drawing designation if any**:

1. Standard: ASME A112.18.1.
2. Type Faucet: **Blending Thermostatic mixing** valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze **with stainless-steel wetted parts**.
6. Body Finish: Rough bronze **or chrome plate**.
7. Mounting: **Wall, with reinforcement Floor, with stainless-steel pedestal**.
8. Supply Fittings: Two **NPS 1/2 NPS 3/4** gate, globe, or ball valves and check valves and **NPS 1/2 NPS 3/4** copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; **25 feet 50 feet Insert length** long.
10. Nozzle: With hand squeeze on-off control.
11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

D. Cold-Water and Steam Hose Stations **Insert drawing designation if any**:

1. Standard: ASME A112.18.1.
2. Type Faucet: **Blending Thermostatic mixing** valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze **with stainless-steel wetted parts**.
6. Body Finish: Rough bronze **or chrome plate**.
7. Mounting: **Wall, with reinforcement Floor, with stainless-steel pedestal**.
8. Supply Fittings: Two **NPS 1/2 NPS 3/4** gate, globe, or ball valves and check valves and **NPS 1/2 NPS 3/4** copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; **25 feet 50 feet Insert length** long.
10. Nozzle: With hand squeeze on-off control.
11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

2.8 HOSE BIBBS

A. Hose Bibbs **Insert drawing designation if any**:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral **or field-installation,** nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: **Rough bronze Chrome or nickel plated**.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: **Wheel handle Operating key**.
13. Operation for Finished Rooms: **Wheel handle Operating key**.
14. Include operating key with each operating-key hose bibb.
15. Include **integral** wall flange with each chrome- or nickel-plated hose bibb.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company.

b. MIFAB, Inc.
c. Prier Products, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Woodford Manufacturing Company.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Specification Drainage Operation.
j. Insert manufacturer's name.

2. Standard: ASME A112.21.3M for **concealed exposed**-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: **Polished nickel bronze Chrome plated Insert finish**.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: **Polished nickel bronze Rough bronze Insert finish**.
12. Operating Keys(s): **One Two** with each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company.
b. Prier Products, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Woodford Manufacturing Company.
g. Zurn Plumbing Products Group; Specification Drainage Operation.
h. Insert manufacturer's name.

2. Standard: ASME A112.21.3M for **concealed exposed**-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casings and Operating Rods: Of length required to match wall thickness. Include wall clamps.
6. Inlets: NPS 3/4 or NPS 1.
7. Outlet: Concealed.
8. Box: Deep, flush mounting with cover.

9. Box and Cover Finish: **Polished nickel bronze Chrome plated Insert finish**.
10. Vacuum Breaker: Nonremovable, manual-drain-type, hose-connection **vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052** and with garden-hose thread complying with ASME B1.20.7 on outlet.
11. Operating Keys(s): **One Two** with each wall hydrant.

C. Moderate-Climate Wall Hydrants **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company.
    b. MIFAB, Inc.
    c. Prier Products, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products Inc.
    g. Woodford Manufacturing Company.
    h. Zurn Plumbing Products Group; Light Commercial Operation.
    i. Zurn Plumbing Products Group; Specification Drainage Operation.
    j. Insert manufacturer's name.

2. Standard: ASME A112.21.3M for **concealed exposed**-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker or nonremovable hose-connection **vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052**; and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounting with cover.
8. Box and Cover Finish: **Polished nickel bronze Chrome plated Insert finish**.
9. Outlet: Exposed, with integral vacuum breaker or nonremovable hose-connection **vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052**; and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: **Polished nickel bronze Rough bronze Insert finish**.
11. Operating Keys(s): **One Two** with each wall hydrant.

D. Vacuum Breaker Wall Hydrants **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Arrowhead Brass Products, Inc.
    b. Mansfield Plumbing Products LLC.
    c. McDonald, A. Y. Mfg. Co.
    d. Prier Products, Inc.
    e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.

f. Watts Industries, Inc.; Water Products Div.
g. Woodford Manufacturing Company.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Insert manufacturer's name.

2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: **Type A, for automatic draining with hose removed or** Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig.
6. Operation: **Loose key Loose key or wheel handle Wheel handle**.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.10 GROUND HYDRANTS

A. Nonfreeze Ground Hydrants **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company.
b. MIFAB, Inc.
c. Murdock, Inc.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products Inc.
h. Woodford Manufacturing Company.
i. Zurn Plumbing Products Group; Light Commercial Operation.
j. Zurn Plumbing Products Group; Specification Drainage Operation.
k. Insert manufacturer's name.

2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, concealed-outlet ground hydrant with box.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Inlet: NPS 3/4.
7. Outlet: Garden-hose thread complying with ASME B1.20.7.
8. Drain: Designed with hole to drain into ground when shut off.
9. Box: **Standard Deep** pattern with cover.
10. Box and Cover Finish: **Rough Polished nickel Insert finish** bronze.
11. Operating Key(s): **One Two** with each ground hydrant.
12. Vacuum Breaker: ASSE 1011.

2.11 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MIFAB, Inc.
   b. Prier Products, Inc.
   c. Simmons Manufacturing Co.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Woodford Manufacturing Company.
   h. Zurn Plumbing Products Group; Light Commercial Operation.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
   j. Insert manufacturer's name.

2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, exposed-outlet post hydrant.
4. Operation: Loose key.
5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
6. Casing: Bronze with casing guard.
7. Inlet: NPS 3/4.
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain into ground when shut off.
10. Vacuum Breaker: Nonremovable, drainable, hose-connection **vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052**; and garden-hose thread complying with ASME B1.20.7 on outlet.
11. Operating Key(s): **One Two** with each loose-key-operation wall hydrant.

B. Nonfreeze, Nondraining-Type Post Hydrants **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Murdock, Inc.
   b. Insert manufacturer's name.

2. Operation: Lever-piston operating mechanism and nondraining water-storage reservoir, designed without drain
3. Length: As required for burial of valve below frost line.
4. Inlet: NPS 1 threaded.
5. Outlet: **NPS 1 outlet and coupling plug for 1-inch hose NPS 1 by NPS 3/4 adapter with nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011; and garden-hose thread complying with ASME B1.20.7 on outlet or NPS 1 by NPS 3/4 adapter with nonremovable, drainable, hose-connection backflow**

preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

C. Freeze-Resistant Sanitary Yard Hydrants **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hoeptner Products.
   b. Insert manufacturer's name.

2. Standard: ASSE 1057, Type 5 for nondraining hydrants.
3. Operation: Wheel handle.
4. Head: Copper alloy, with pail hook.
5. Inlet: NPS 3/4-inch threaded inlet and inlet nozzle, galvanized-steel riser, and venturi.
6. Canister: **Plastic Zinc-plated steel** with atmospheric-vent device.
7. Vacuum Breaker: Removable hose-connection backflow preventer complying with ASSE 1052 with garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.12 WATER HAMMER ARRESTERS

A. Water Hammer Arresters **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. PPP Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.
   j. **Insert manufacturer's name**.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: **Metal bellows Copper tube with piston**.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.13 AIR VENTS

A. Bolted-Construction Automatic Air Vents **Insert drawing designation if any**:

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 3/8 NPS 1/2** minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents **Insert drawing designation if any**:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.14 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MIFAB, Inc.
   b. PPP Inc.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Watts Industries, Inc.; Water Products Div.
   f. Insert manufacturer.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Valves **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   b. Insert manufacturer.

2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

2.15 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. PPP Inc.
   b. Insert manufacturer.

2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: **Recessed Surface**-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: **Four Six Eight Insert number**.
8. Size Outlets: **NPS 1/2 NPS 5/8**.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" 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. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves **and bypass with memory-stop balancing valve**. Install pressure gages on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves **and bypass with globe valve**. Install pressure gages on inlet and outlet.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.

2. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Install Y-pattern strainers for water on supply side of each **control valve, water pressure-reducing valve, solenoid valve, and pump**.

H. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

I. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install shutoff valve on outlet if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2- by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

J. Install ground hydrants with **1 cu. yd. Insert dimension** of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

K. Install draining-type post hydrants with **1 cu. yd. Insert dimension** of crushed gravel around drain hole. Set post hydrants in concrete paving or in **1 cu. ft. Insert dimension** of concrete block at grade.

L. Install nonfreeze, nondraining-type post hydrants set in concrete or pavement.

M. Install freeze-resistant yard hydrants with riser pipe set in concrete or pavement. Do not encase canister in concrete.

N. Install water hammer arresters in water piping according to PDI-WH 201.

O. Install air vents at high points of water piping. **Install drain piping and discharge onto floor drain.**

P. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

Q. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

R. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Double-check backflow-prevention assemblies.
5. Carbonated-beverage-machine backflow preventers.
6. Dual-check-valve backflow preventers.
7. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
8. Double-check, detector-assembly backflow preventers.
9. Water pressure-reducing valves.
10. Calibrated balancing valves.
11. Primary, thermostatic, water mixing valves.
12. Manifold, thermostatic, water-mixing-valve assemblies.
13. Photographic-process, thermostatic, water-mixing-valve assemblies.
14. Primary water tempering valves.
15. Outlet boxes.
16. Hose stations.
17. Supply-type, trap-seal primer valves.
18. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each **pressure vacuum breaker reduced-pressure-principle backflow preventer double-check backflow-prevention assembly and double-check, detector-assembly backflow preventer Insert type** according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT 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. This 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.

B. Related Sections include the following:

1. Division 22 Section "Sanitary Sewerage Pumps."
2. Division 22 Section "Chemical Waste-Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 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 Insert pressure**.
2. Sanitary Sewer, Force-Main Piping: **50 psig 100 psig 150 psig Insert pressure**.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to **ASCE 7, "Minimum Design Loads for Buildings and Other Structures." Insert applicable code requirement.**

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:

1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
2. Sovent Drainage System: Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

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 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 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

a. **Available** Manufacturers:

1) ANACO.
2) Fernco, Inc.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.
6) Insert manufacturer's name.

2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a. **Available** Manufacturers:

1) ANACO.
2) Clamp-All Corp.
3) Ideal Div.; Stant Corp.
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.
6) Insert manufacturer's name.

3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.

a. **Available** Manufacturers:

1) MG Piping Products Co.
2) Insert manufacturer's name.

D. Rigid, Unshielded 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. **Available** Manufacturers:

a. ANACO.
b. Insert manufacturer's name.

2.5 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12**, galvanized**, threaded, cast-iron drainage pattern.

C. Pressure Fittings:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, **galvanized,** standard pattern.
4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125**, galvanized**.

D. Grooved-Joint Systems:

1. **Available** Manufacturers:

a. Anvil International.
b. Star Pipe Products; Star Fittings Div.
c. Victaulic Company.
d. Ward Manufacturing, Inc.
e. Insert manufacturer's name.

2. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, **galvanized,** malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, **galvanized,** ductile-iron casting; with dimensions matching steel pipe.
3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.6 STAINLESS-STEEL PIPE AND FITTINGS

A. Pipe and Fittings: ASME A112.3.1, drainage pattern with socket and spigot ends.

B. Gaskets: Lip seals shaped to fit socket groove, with plastic backup ring.

1. Material: EPDM, unless NBR is indicated.

2.7 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. 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.

C. Grooved-Joint Systems:

1. **Available** Manufacturers:

a. Victaulic Company.
b. Insert manufacturer's name.

2. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

D. Flanges: ASME 16.1, Class 125, cast iron.

2.8 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M, 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. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
3. 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.

C. Soft Copper Tube: ASTM B 88, Type L, 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.

2.9 ABS PIPE AND FITTINGS

A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

2.10 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.

1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

2.11 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. **Available** Manufacturers:

a. Dallas Specialty & Mfg. Co.
b. Fernco, Inc.
c. Logan Clay Products Company (The).
d. Mission Rubber Co.
e. NDS, Inc.
f. Plastic Oddities, Inc.
g. Insert manufacturer's name.

2. 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.

1. **Available** Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Mission Rubber Co.
c. Insert manufacturer's name.

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. **Available** Manufacturers:

a. ANACO.
b. Insert manufacturer's name.

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. **Available** Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.; DMD Div.
c. EBAA Iron Sales, Inc.
d. Ford Meter Box Company, Inc. (The); Pipe Products Div.
e. JCM Industries, Inc.
f. Romac Industries, Inc.
g. Smith-Blair, Inc.
h. Viking Johnson.
i. Insert manufacturer's name.

2. Center-Sleeve Material: **Manufacturer's standard Carbon steel Stainless steel Ductile iron Malleable iron**.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

E. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

1. **Available** Manufacturers:

a. EBAA Iron Sales, Inc.
b. Insert manufacturer's name.

F. 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.

1. **Available** Manufacturers:

a. EBAA Iron Sales, Inc.
b. Romac Industries, Inc.
c. Star Pipe Products; Star Fittings Div.
d. Insert manufacturer's name.

G. 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.

1. **Available** Manufacturers:

a. SIGMA Corp.
b. Insert manufacturer's name.

2.12 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, **high-density, crosslaminated PE film of 0.004-inch or LLDPE film of 0.008-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 "Earth Moving" 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 4 and smaller Insert pipe size range** shall be **any of** the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless cast-iron soil pipe and fittings **and sovent stack fittings**; **standard, shielded, stainless-steel heavy-duty shielded, stainless-steel and rigid, unshielded** couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
5. Copper DWV tube, copper drainage fittings, and soldered joints.
6. **Solid-wall Cellular-core** ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. **Solid-wall Cellular-core** PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: **Flexible, Shielded, Rigid, unshielded,** nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, soil and waste piping **NPS 5 and larger Insert pipe size range** shall be **any of** the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings **and sovent stack fittings**; **standard, and heavy-duty** shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. **Solid-wall Cellular-core** PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: **Flexible, Shielded,** nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Aboveground, vent piping **NPS 4 and smaller Insert pipe size range** shall be **any of** the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; **standard, shielded, stainless-steel heavy-duty shielded, stainless-steel and rigid, unshielded** couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings gaskets, and gasketed joints.
5. Copper DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

6. **Solid-wall Cellular-core** ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. **Solid-wall Cellular-core** PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: **Flexible, Shielded, Rigid, unshielded,** nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Aboveground, vent piping **NPS 5 and larger Insert pipe size range** shall be **any of** the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; **standard, and heavy-duty** shielded, stainless-steel couplings; and hubless-coupling joints.
3. Steel pipe, drainage fittings, and threaded joints.
4. **Solid-wall Cellular-core** PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: **Flexible, Shielded,** nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

F. Underground, soil, waste, and vent piping **NPS 4 and smaller Insert pipe size range** shall be **any of** the following:

1. **Extra-Heavy Service** class, cast-iron soil piping; **gaskets; and gasketed calking materials; and calked** joints.
2. Hubless cast-iron soil pipe and fittings; **standard, shielded, stainless-steel heavy-duty shielded, stainless-steel heavy-duty shielded, cast-iron and rigid, unshielded** couplings; and hubless-coupling joints.
3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
4. **Cellular-core Solid wall** ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. **Cellular-core Solid wall** PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
7. Dissimilar Pipe-Material Couplings: **Flexible, Shielded, Rigid, unshielded,** nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

G. Underground, soil and waste piping **NPS 5 and larger Insert pipe size range** shall be **any of** the following:

1. **Extra-Heavy Service** class, cast-iron soil piping; **gaskets; and gasketed calking materials; and calked** joints.
2. Hubless cast-iron soil pipe and fittings; **standard, shielded, stainless-steel heavy-duty shielded, stainless-steel and heavy-duty shielded, cast-iron** couplings; and hubless-coupling joints.
3. **Cellular-core Solid-wall**, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
4. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: **Flexible, Shielded,** nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

H. Aboveground sanitary-sewage force mains **NPS 1-1/2 and NPS 2 Insert pipe size range** shall be **any of** the following:

1. Hard copper tube, **Type L Type M**; copper pressure fittings; and soldered joints.
2. Steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains **NPS 2-1/2 to NPS 6 Insert pipe size range** shall be **any of** the following:

1. Hard copper tube, **Type L Type M**; copper pressure fittings; and soldered joints.
2. Steel pipe, pressure fittings, and threaded joints.
3. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.

J. Underground sanitary-sewage force mains **NPS 4 and smaller Insert pipe size range** shall be **any of** the following:

1. **Hard Soft** copper tube, Type L; **wrought**-copper pressure fittings; and soldered joints.
2. Steel pipe, pressure fittings, and threaded joints.

a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

3. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.

a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

4. Push-on-joint, ductile-iron pipe; push-on-joint ductile-iron fittings; gaskets; and gasketed joints.

a. Include grooved-joint system fittings and couplings and grooved joints where indicated.

5. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

K. Underground sanitary-sewage force mains **NPS 5 and larger Insert pipe size range** shall be **any of** the following:

1. Steel pipe, pressure fittings, and threaded joints.
2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical-joint joints.
3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron fittings; gaskets; and gasketed joints.
4. 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 Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. Install underground, steel, force-main piping. **Install encasement on piping according to ASTM A 674 or AWWA C105.**

G. 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.

H. 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.

I. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

J. 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 22 Section "Common Work Results for Plumbing."

K. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

L. 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.

M. 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 drain pipe. 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.

N. 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.

O. 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.

P. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

Q. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

R. Install ABS soil and waste drainage and vent piping according to ASTM D 2661.

S. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

T. Install underground **ABS and PVC** soil and waste drainage piping according to ASTM D 2321.

U. 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 22 Section "Common Work Results for Plumbing."

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. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

E. 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.

F. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

G. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.

1. Install gate or full-port ball 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 sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.

1. Horizontal Piping: Horizontal backwater valves. **Use normally closed type, unless otherwise indicated.**
2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. 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. 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.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. 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.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. 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.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.
2. NPS 3: 96 inches with 1/2-inch rod.
3. NPS 4: 108 inches with 1/2-inch rod.
4. NPS 6: 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

L. 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.

M. Install supports for vertical copper tubing every 10 feet.

N. Install hangers for **ABS and PVC** piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

O. Install supports for vertical **ABS and PVC** piping every 48 inches.

P. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

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. 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. 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 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 CLEANING

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.

3.10 PROTECTION

A. Exposed **ABS and PVC** Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING 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. This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Trench drains.
5. Channel drainage systems.
6. Air-admittance valves.
7. Roof flashing assemblies.
8. Through-penetration firestop assemblies.
9. Miscellaneous sanitary drainage piping specialties.
10. Flashing materials.
11. Grease interceptors.
12. Grease removal devices.
13. Oil interceptors.
14. Solids interceptors.

B. Related Sections include the following:

1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Division 22 Section "Plumbing Fixtures" for hair interceptors.
3. Division 22 Section "Healthcare Plumbing Fixtures" for plaster sink interceptors.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. FOG disposal systems.
2. Grease interceptors.
3. Grease removal devices.
4. Oil interceptors.

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that **FOG disposal systems, grease interceptors, grease removal devices, oil interceptors,** accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 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 piping specialty components.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

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. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to **200 Insert number** percent of amount installed, but no fewer than **2 Insert number** 1-gal. bottles.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. MIFAB, Inc.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group.

2. Standard: ASME A112.14.1.
3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with threaded access check valve.
6. End Connections: **Hubless**.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang **open for airflow unless subject to backflow condition**.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. Watts Drainage Products Inc.
   c. Zurn Plumbing Products Group;

2. Size: Same as floor drain outlet.
3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.2 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MIFAB, Inc.
   b. Watts Drainage Products Inc.
   c. Zurn Plumbing Products Group.

2. Standard: **ASME A112.36.2M for cast iron** for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: **Hubless, cast-iron soil pipe test tee** as required to match connected piping.
5. Closure: **Countersunk or raised-head brass** plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Watts Drainage Products Inc.
   b. Mifab
   c. Zurn Plumbing Products Group.

2. Standard: ASME A112.36.2M for **heavy duty, adjustable housing** cleanout.
3. Size: Same as connected branch.
4. Type: **Adjustable housing**.
5. Body or Ferrule: **Cast iron**.

6. Clamping Device: **Required**.
7. Outlet Connection: **Threaded**.
8. Closure: **Brass plug with straight threads and gasket**.
9. Adjustable Housing Material: **Cast iron** with **threads.**
10. Frame and Cover Material and Finish: **Nickel-bronze, copper alloy**.
11. Frame and Cover Shape: **Coordinate with Architect**.
12. Top Loading Classification: **Heavy** Duty.
13. Riser: ASTM A 74, **Extra-Heavy** class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. MIFAB, Inc.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: **Hubless, cast-iron soil pipe test tee** as required to match connected piping.
5. Closure: **drilled-and-threaded brass cast-iron** plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, **flat, chrome-plated brass or stainless-steel** cover plate with screw.
8. Wall Access: Provide **Round or Square**, **stainless-steel** wall-installation frame and cover.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. MIFAB, Inc.
    b. Watts Drainage Products Inc.
    c. Zurn Plumbing Products Group.

2. Standard: ASME A112.6.3.
3. Pattern: **See plumbing plans**.
4. Body Material: **See plumbing plans**.

5. Seepage Flange: **Required**.
6. Anchor Flange: **See plumbing plans**
7. Clamping Device: **Required**.
8. Outlet: **See plumbing plans**
9. Backwater Valve: **See plumbing plans**
10. Coating on Interior and Exposed Exterior Surfaces: See plumbing plans.
11. Sediment Bucket: **See plumbing plans**.
12. Top or Strainer Material: **See plumbing plans**
13. Top of Body and Strainer Finish: **See plumbing plans**
14. Top Shape: **See plumbing plans**
15. Dimensions of Top or Strainer: **See plumbing plans**
16. Top Loading Classification: **Heavy Duty**.
17. Funnel: **See plumbing plans**
18. Inlet Fitting: **See plumbing plans**
19. Trap Material: **See plumbing plans.**
20. Trap Pattern: **Cast Iron.**
21. Trap Features: **See plumbing plans.**

2.4 TRENCH DRAINS

A. Trench Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MIFAB, Inc.
   b. Watts Drainage Products Inc.
   c. Zurn Plumbing Products Group.

2. Standard: ASME A112.6.3 for trench drains.
3. Material: Ductile or gray iron.
4. Flange: **Anchor and Seepage**.
5. Clamping Device: **See plumbing plans**.
6. Outlet: **See plumbing plans.**
7. Grate Material: **See plumbing plans**
8. Grate Finish: **See plumbing plans**.
9. Dimensions of Frame and Grate: **See plumbing plans.**
10. Top Loading Classification: **See plumbing plans.**
11. Trap Material: **See plumbing plans.**
12. Trap Pattern: **See plumbing plans**.

2.5 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Blucher-Josam Div.
    b. Insert manufacturer's name.
    c. MultiDrain Systems.
    d. Zurn Plumbing Products Group; Flo-Thru Operation.
    e. Insert manufacturer's name.

2. Type: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

    a. Standard: ASME A112.3.1, for trench drains.
    b. Channel Sections: Interlocking-joint, stainless-steel with level invert.

        1) Dimensions: **5.8 inches 11.7 inches** wide. Include number of units required to form total lengths indicated.

    c. Grates: Manufacturer's designation "**heavy medium** duty," with slots or perforations, and of width and thickness that fit recesses in channels.

        1) Material: **Ductile iron Fiberglass Galvanized steel Gray iron Stainless steel Insert material**.
        2) Locking Mechanism: **Manufacturer's standard device for securing grates to channel sections Not required**.

    d. Covers: Solid **ductile or gray iron stainless steel Insert material**, of width and thickness that fit recesses in channels, and of lengths indicated.
    e. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
    f. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

3. Type: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

    a. Channel Sections: Interlocking-joint, stainless steel with level invert.

        1) Dimensions: **6 inches 12 inches** wide. Include number of units required to form total lengths indicated.

    b. Grates: Manufacturer's designation "**heavy medium** duty," with slots or perforations, and of width and thickness that fit recesses in channels.

        1) Material: **Ductile iron Fiberglass Galvanized steel Gray iron Stainless steel Insert material**.
        2) Locking Mechanism: **Manufacturer's standard device for securing grates to channel sections Not required**.

    c. Covers: Solid **ductile or gray iron stainless steel Insert material**, of width and thickness that fit recesses in channels, and of lengths indicated.

d. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

B. Polymer-Concrete Channel Drainage Systems **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABT, Inc.
b. ACO Polymer Products, Inc.
c. Forte Composites, Inc.
d. Josam Company; Mea-Josam Div.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Strongwell Corporation; Lenoir City Division.
g. Insert manufacturer's name.
h. ABT, Inc.
i. ACO Polymer Products, Inc.
j. Forte Composites, Inc.
k. Josam Company; Mea-Josam Div.
l. Insert manufacturer's name.
m. ABT, Inc.
n. ACO Polymer Products, Inc.
o. Josam Company; Mea-Josam Div.
p. Strongwell Corporation; Lenoir City Division.
q. Insert manufacturer's name.

2. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

a. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.

1) Dimensions: 4-inch inside width. Include number of units required to form total lengths indicated.
2) Frame: **Gray-iron or galvanized steel for grates Not required**.

b. Grates: Manufacturer's designation "**heavy medium** duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

1) Material: **Ductile iron Fiberglass Galvanized steel Gray iron Stainless steel Insert material**.
2) Locking Mechanism: **Manufacturer's standard device for securing grates to channel sections Not required**.

c. Covers: Solid **ductile or gray iron Insert material**, of width and thickness that fit recesses in channel sections, and of lengths indicated.

d. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
f. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps. Include rounded bottom, with level invert and with NPS 4 outlets in number and locations indicated.

    1) Dimensions: **5-inch Insert dimension** inside width and **9-3/4 inches Insert dimension** deep. Include number of units required to form total lengths indicated.
    2) Frame: **Gray-iron or galvanized steel for grates Not required**.

g. Grates: Manufacturer's designation "**heavy medium** duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

    1) Material: **Ductile iron Fiberglass Galvanized steel Gray iron Stainless steel Insert material**.
    2) Locking Mechanism: **Manufacturer's standard device for securing grates to channel sections Not required**.

h. Covers: Solid **ductile or gray iron Insert material**, of width and thickness that fit recesses in channel sections, and of lengths indicated.
i. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
j. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
k. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.

    1) Dimensions: **8-inch Insert dimension** inside width and **13-3/4 inches Insert dimension** deep. Include number of units required to form total lengths indicated.
    2) Frame: **Gray-iron or galvanized steel for grates Not required**.

l. Grates: Manufacturer's designation "**heavy medium** duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

    1) Material: **Ductile iron Fiberglass Galvanized steel Gray iron Stainless steel Insert material**.
    2) Locking Mechanism: **Manufacturer's standard device for securing grates to channel sections Not required**.

m. Covers: Solid **ductile or gray iron Insert material**, of width and thickness that fit recesses in channel sections, and of lengths indicated.
n. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
o. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. Polymer-Concrete Sediment Interceptor **Insert drawing designation if any**:

1. Description: **27-inch- Insert dimension** square, precast, polymer-concrete body, with outlets in number and sizes indicated. Include 24-inch- square, gray-iron slotted grate.
2. Frame: **Gray-iron or galvanized steel for grate Not required**.

D. FRP Channel Drainage Systems **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ACO Polymer Products, Inc.
   b. Aquaduct, Inc.; an ACO Polymer Products, Inc. Company.
   c. Josam Company; Mea-Josam Div.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Zurn Plumbing Products Group; Flo-Thru Operation.
   f. Insert manufacturer's name.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

   a. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.

      1) Dimensions: **4 inches 4 or 6 inches 6 inches 6 or 8 inches 8 inches** wide. Include number of units required to form total lengths indicated.
      2) Frame: **Galvanized steel Stainless steel Manufacturer's standard metal Insert material** for grates.

   b. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

      1) Material: **Fiberglass Galvanized steel Gray iron Stainless steel Insert material**.
      2) Locking Mechanism: **Manufacturer's standard device for securing grates to channel sections Not required**.

   c. Covers: Solid **ductile or gray iron Insert material**, of width and thickness that fit recesses in channel sections, and of lengths indicated.
   d. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
   e. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

E. Plastic Channel Drainage Systems **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
b. Tuf-Tite Corporation.
c. Zurn Plumbing Products Group; Flo-Thru Operation.
d. Insert manufacturer's name.
e. Infinity Plastics, Inc.
f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
g. Insert manufacturer's name.
h. MultiDrain Systems.
i. NDS Inc.
j. Insert manufacturer's name.
k. Infinity Plastics, Inc.
l. MultiDrain Systems.
m. NDS Inc.
n. Smith, Jay R. Mfg Co.; Division of Smith Industries, Inc.
o. Tuf-Tite Corporation.
p. Zurn Plumbing Products Group; Flo-Thru Operation.
q. Insert manufacturer's name.

2. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

a. Channel Sections: Interlocking-joint, **HDPE or PE PP or PVC** modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

1) Dimensions: 4 inches wide. Include number of units required to form total lengths indicated.

b. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

1) Material: **Fiberglass Galvanized steel Gray iron Stainless steel Insert material**.
2) Color: **Insert color or delete subparagraph.**

c. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
d. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.6 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ayrlett, LLC.
b. Durgo, Inc.

c. Oatey.
d. ProSet Systems Inc.
e. RectorSeal.
f. Studor, Inc.

2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Durgo, Inc.
b. Oatey.
c. Studor, Inc.

2. Standard: ASSE 1050 for vent stacks.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected stack vent or vent stack.

C. Wall Box:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Durgo, Inc.
b. Oatey.
c. RectorSeal.
d. Studor, Inc.

2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.7 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Engineering Company; Elmdor/Stoneman Div.

b. Thaler Metal Industries Ltd.
c. Approved equal

B. Description: Manufactured assembly made of **4.0-lb/sq. ft., 0.0625-inch- 6.0-lb/sq. ft., 0.0938-inch-** thick, lead flashing collar and skirt extending at least **6 inches 8 inches 10 inches** from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.8 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, manufactures offering products that may be incorporated into the work include the following criteria:
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

2.9 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping**, minimum 4”**.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2: 4-inch- minimum water seal.
b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend **2 inches** above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.10 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 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.

2.11 GREASE INTERCEPTORS

A. Grease Interceptors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Applied Chemical Technology, Incorporated.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Rockford Sanitary Systems, Inc.
e. Schier Products Company.
f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products Inc.
i. Zurn Plumbing Products Group; Light Commercial Operation.
j. Zurn Plumbing Products Group; Specification Drainage Operation.
k. Insert manufacturer's name.
l. Ashland Trap Distribution Co.
m. Bio-Microbics, Inc.
n. Canplas LLC.
o. Schier Products Company.
p. Zurn Plumbing Products Group; Light Commercial Operation.
q. Insert manufacturer's name.

2. Standard: ASME A112.14.3 **and PDI-G101**, for intercepting and retaining fats, oils, and greases from food-**preparation or -processing** wastewater.

3. Plumbing and Drainage Institute Seal: **Not required Required**.
4. Body Material: **Cast iron Cast iron or steel Plastic Insert material**.
5. Interior Lining: **Corrosion-resistant enamel Not required Insert lining**.
6. Exterior Coating: **Corrosion-resistant enamel Not required Insert coating**.
7. Body Dimensions: **Insert dimensions.**
8. Body Extension: **Not required Required**.
9. Flow Rate: **Insert interceptor design rate.**
10. Grease Retention Capacity: **Insert capacity.**
11. Inlet and Outlet Size: **Insert size.**
12. End Connections: **Flanged Hub Threaded**.
13. Cleanout: Integral **or field installed on outlet**.
14. Mounting: **Above floor Recessed in acid-resistant, coated steel frame and cradle Recessed, flush with floor Insert mounting**.
15. Flow-Control Fitting: **Not required Required**.
16. Operation: **Automatic recovery Manual cleaning Semiautomatic, manual drawoff Insert operation**.

2.12 OIL INTERCEPTORS

A. Oil Interceptors **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Applied Chemical Technology, Incorporated.
    b. Josam Company; Josam Div.
    c. MIFAB, Inc.
    d. Rockford Sanitary Systems, Inc.
    e. Schier Products Company.
    f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    g. Tyler Pipe; Wade Div.
    h. Watts Drainage Products Inc.
    i. Zurn Plumbing Products Group; Specification Drainage Operation.
    j. Insert manufacturer's name.
    k. Ashland Trap Distribution Co.
    l. Schier Products Company.
    m. Town & Country Plastics, Inc.
    n. Insert manufacturer's name.

2. Type: Factory-fabricated interceptor for separating and removing **light oil Insert type of oil** from wastewater.
3. Body Material: **Cast iron or steel Plastic Insert material**.
4. Interior Lining: **Corrosion-resistant enamel Not required Insert lining**.
5. Exterior Coating: **Corrosion-resistant enamel Not required Insert coating**.
6. Body Dimensions: **Insert dimensions.**
7. Flow Rate: **Insert interceptor design rate.**
8. Inlet and Outlet Size: **Insert size.**
9. End Connections: **Flanged Hub Threaded**.
10. Cleanout: Integral **or field installed on outlet**.

11. Mounting: **Above floor Recessed in acid-resistant, coated steel frame and cradle Recessed, flush with floor Insert mounting**.
12. Flow-Control Fitting: **Not required Required**.
13. Descriptive Type or Function: **Describe type or function or delete subparagraph.**
14. Oil Storage Tank: **Coordinate with Division 23 Section "Facility Fuel-Oil Piping." Insert tank description.**

2.13 SOLIDS INTERCEPTORS

A. Solids Interceptors **Insert drawing designation if any**:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Rockford Sanitary Systems, Inc.
    d. Schier Products Company.
    e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    f. Tyler Pipe; Wade Div.
    g. Watts Drainage Products Inc.
    h. Zurn Plumbing Products Group; Specification Drainage Operation.
    i. Insert manufacturer's name.
    j. Ashland Trap Distribution Co.
    k. Schier Products Company.
    l. Town & Country Plastics, Inc.
    m. Insert manufacturer's name.

2. Type: Factory-fabricated interceptor made for removing and retaining **lint sediment Insert solid** from wastewater.
3. Body Material: **Cast iron or steel Stainless steel Plastic Insert material**.
4. Interior Separation Device: **Baffles Screens Insert device**.
5. Interior Lining: **Corrosion-resistant enamel Not required Insert lining**.
6. Exterior Coating: **Corrosion-resistant enamel Not required Insert coating**.
7. Body Dimensions: **Insert dimensions.**
8. Flow Rate: **Not required Insert description if required**.
9. Inlet and Outlet Size: **Insert size.**
10. End Connections: **Threaded Insert connections**.
11. Mounting: **Above floor Inline Insert mounting**.

2.14 MOTORS

A. General requirements for motors are specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

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: Electrical devices and connections are specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Anchor **FOG disposal systems grease interceptors grease removal devices and solids interceptors** to concrete bases.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 19-inch centers around full perimeter of base.
2. For installed 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 imbedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.2 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. 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.

G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

H. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.

I. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

J. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

K. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

L. Install fixture air-admittance valves on fixture drain piping.

M. Install stack air-admittance valves at top of stack vent and vent stack piping.

N. Install air-admittance-valve wall boxes recessed in wall.

O. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

P. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

Q. Install through-penetration firestop assemblies in plastic **conductors and stacks** at floor penetrations.

R. Assemble open drain fittings and install with top of hub **1 inch 2 inches Insert dimension** above floor.

S. Install deep-seal traps on floor drains and other waste outlets, if indicated.

T. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

U. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

V. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

W. Install vent caps on each vent pipe passing through roof.

X. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

Y. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

Z. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

AA. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

BB. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.

CC. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 23 Section "Facility Fuel-Oil Piping."

DD. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

EE. Install wood-blocking reinforcement for wall-mounting-type specialties.

FF. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

GG. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

D. Grease Removal Devices: Connect controls, electrical power, factory-furnished accessories, and inlet, outlet, and vent piping to unit.

E. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 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.
2. Copper Sheets: Solder joints of copper sheets.

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.

3.5 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Grease interceptors.
2. Grease removal devices.
3. Oil interceptors.
4. Solids interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

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.

3.7 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.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain **grease removal devices**. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 221319

SECTION 23 01 30.51

HVAC AIR-DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cleaning of interior surfaces of HVAC equipment. The HVAC equipment cleaning work includes the following:

1. Air handling units including, but not limited to, preheat, reheat, and cooling coils, bypass dampers, fans, plenums, and zone dampers.
2. Duct-mounted reheat coils, VAV boxes, fan powered boxes, unit ventilators, fan coil units, unit heaters, baseboards, and exhaust fans.
3. Air distribution devices (registers, grilles, and diffusers).

B. The HVAC equipment cleaning work includes verification, through inspection and/or testing by the cleaning contractor, as specified herein and as indicated in referenced NADCA standards.

C. The HVAC equipment cleaning work does not include cleaning of existing or installed ductwork.

1.2 DEFINITIONS

A. ASCS: Air System Cleaning Specialist.

B. NADCA: National Air Duct Cleaners Association.

C. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.3 SUBMITTALS

A. Manufacturer Certificates: Signed by manufacturer certifying that products comply with requirements.

B. Qualifications: For Cleaning Contractor and project supervisor.

C. Field Test Reports: Certified copies of field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Contractor Qualifications: Subcontract the HVAC cleaning work to a single firm that specializes in the cleaning of HVAC equipment, with a minimum 5 years successful experience in cleaning HVAC equipment comparable to that shown for the project, in not less than 3 projects of similar scope, to the satisfaction of the Architect; that is a certified member of the National Air Duct Cleaners Association (NADCA); that employs not less than one (1) Air System Cleaning Specialist (ASCS), as certified by NADCA, on a full time basis; that will provide an Air System Cleaning Specialist as a project supervisor on a full time basis; that has organized quality control and testing procedures, to properly verify the results of the cleaning

work; and that can provide the necessary equipment, materials, and labor to adequately perform the cleaning work without causing any delay in the project.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Biocidal Agents: Registered with the U.S. Environmental Protection Agency (EPA) for use within HVAC systems.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine existing systems, adjacent construction, and conditions under which work is to be performed to determine appropriate methods, tools, and equipment required for performance of work.

1. Damaged components with the HVAC systems and conditions detrimental to the performance of the work discovered during the examination shall be documented in a written report and submitted to the Board Authorized Representative.

B. Record and mark settings of controls, dampers, and other directional devices within the HVAC system, to ensure those components can be returned to those settings at the completion of the HVAC cleaning work.

C. Perform “Project Evaluation and Recommendation” according to NADCA ACR 2006.

D. Proceed with work only after unsatisfactory conditions have been corrected and after all HVAC equipment renovation has been completed, but prior to the final balancing of the HVAC systems.

3.2 HVAC EQUIPMENT CLEANING

A. General:

1. Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that debris is not dispersed outside the HVAC system during the cleaning process.
2. Particulate Collection: Where the particulate collection equipment is exhausting inside the building. HEPA filtration with 99.97% collection efficiency for 0.3 micron size (or greater) particles shall be used. Mechanical cleaning operations shall be undertaken only with particulate collection equipment in place including adequate filtration to contain debris removed from the HVAC system. When the particulate collection equipment is exhausting outside the building, precautions shall be taken to locate the equipment down wind and away from all air intakes and other points of entry into the building.
3. Controlling odors: Control offensive odors and/or mist vapors during the cleaning process. Refer to Division 01 Section, "Dust, Fume and Odor Control."

4. Cleaning: Visibly clean all system components as defined in applicable NADCA standards. Upon completion, all components must be returned to those settings recorded prior to cleaning operations.
5. Removal: Remove visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications and NADCA recommendations.
6. Verification: Verification of HVAC system cleanliness shall be determined after mechanical cleaning, but before the application of any treatment or introduction of any treatment-related substance, including biocidal agents and coatings.

B. Air-Volume Control Devices: Existing dampers and any-directional mechanical devices inside the HVAC system to remain must have their position marked prior to cleaning and upon completion must be restored to their marked position.

C. Service Openings: Utilize service openings, at various points of the HVAC system for physical and mechanical entry and inspection.

1. Utilize the existing openings already installed in the HVAC system where possible.
2. Other access points shall be provided, where required, and shall be sealed in accordance with industry codes and standards. Refer to Division 23 Sections "Metal Ducts" and "Ductwork Accessories."
3. Closures must not significantly hinder, restrict, or alter the air-flow within the system.
4. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within insulated systems.
5. Openings must not compromise the structural integrity of the system.
6. Construction techniques used in the creation of openings shall conform to requirements of the authority having jurisdiction and applicable NFPA, SMACNA and NADCA standards.
7. Cutting service openings into flexible duct is not permitted.
8. All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location recorded in project record documents.

D. Air Distribution Devices (registers, grilles & diffusers): Clean all existing air distribution devices to remain.

E. Debris disposal: All debris removed from the HVAC System shall become property of the Contractor and shall be removed from the Site and disposed of legally.

F. Source Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods noted in NADCA ACR 2006. The cleaning method(s) selected shall render the HVAC system visibly clean and capable of passing cleaning verification methods and other specified tests. No cleaning method, or combination of methods, should be used which could potentially damage components, or alter the integrity, of the HVAC system.

1. All methods shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure.
2. All vacuum devices, including hand-held and wet vacuums, exhausting air inside the building shall be equipped with HEPA filters (99.97 % efficiency).

3. All vacuum devices exhausting air outside the facility shall be equipped with particulate collection including adequate filtration to contain debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re- enter the facility. Release of debris outdoors shall be done in accordance with requirements of authority having jurisdiction.
4.

G. Biocidal Agents and Coatings:

1. Biocidal agents shall only be applied if active fungal growth is found, or where unacceptable levels of fungal contamination have been verified through the testing.
2. Application of any biocidal agents used to control the growth of fungal or bacteriological contaminants shall be performed after the removal of surface deposits and debris.
3. Only biocidal agents registered by the U. S. Environmental Protection Agency (EPA) specifically for use within HVAC system shall be used.
4. Biocidal agents shall be applied in strict accordance with manufacturer's instructions.
5. Biocidal coating products for both porous and non-porous surfaces shall be EPA registered, water soluble solutions.

H. Cleaning Mineral-Fiber Insulation Components:

1. Fibrous-glass or acoustical insulation elements present in equipment shall be thoroughly cleaned with HEPA vacuuming equipment, with the HVAC system under constant negative pressure. Care shall be taken to ensure that insulation remains dry during cleaning.
2. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests noted and outlined in NADCA ACR 2006.

I. Visual Inspection: The HVAC equipment and systems shall be visually inspected to ensure that no visible contaminants remain following cleaning. Visual inspection shall take place after mechanical cleaning and before the HVAC systems are returned to normal operation.

1. Where contaminants are found, those portions of the HVAC systems shall be re-cleaned and reinspected visually, with this process repeated until all areas of the HVAC systems are found to be free of contaminants.
2. The Owner may engage an independent agent to verify cleanliness through gravimetric or rope testing analysis testing, in accordance with NADCA standards and recommendations.

    a. Any items found shall be documented in a written report, which is to be submitted to the Board Authorized Representative, and those areas of the HVAC systems are to be re-cleaned by the Contractor at no additional cost to the Owner.

J. Adjustment: At the conclusion of the HVAC cleaning work, but before the HVAC systems are returned to normal operation, the Contractor is to return all controls, dampers, and other directional devices within the HVAC system to the settings recorded prior to the start of cleaning.

K. Reporting: Where areas of the HVAC systems have been found to be damaged and/or in need of repair, the Contractor shall prepare a written report indicating the nature and locations of these items. A copy of this report shall be submitted to the Board Authorized Representative.

END OF SECTION

SECTION 23 01 30.52

HVAC AIR-DISTRIBUTION SYSTEM SEALING AND LEAK TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes sealing and leak testing HVAC air distribution systems. All areas within the scope of work are outlined on the plans. The HVAC air distribution system sealing and leak testing work may include the following:

1. Existing Make Up air duct supplying fresh air to each corridor

2. Existing Residential Toilet Exhaust air and laundry room exhaust ductwork

B. The HVAC air distribution systems sealing and testing work includes verification, through inspection and testing by the sealing contractor, as specified herein and as indicated in referenced SMACNA and Aeroseal manufacturer's sealing and testing standards and specifications.

1.2 DEFINITIONS

A. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

B. NADCA: National Air Duct Cleaners Association

C. VOC: Volatile Organic Compound

D. MERV: Minimum Efficiency Reporting Value

1.3 SUBMITTALS

A. Manufacturer Certificates: Signed by manufacturer certifying that products comply with requirements.

B. Qualifications: For Sealing and Leak Testing Contractor and project supervisor.

C. Field Test Reports: Certified copies of field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Contractor Qualifications: HVAC air distribution systems sealing and testing work to be done by a contractor specializes in the sealing and leak testing of commercial HVAC air distribution systems. The contractor shall be trained and qualified by the Aeroseal manufacturer supplying the products. The contractor shall have a minimum of 2 yrs. commercial air duct sealing experience using Aeroseal products.

1.5 WARRANTY

A. Contractor shall warrant that the aerosol sealant application will be free from defects for a period of 3 years from date of the sealing application. If defects should occur during this period, the Contractor shall repair or replace the defective duct seals, including the direct labor costs for performing the repair or replacement, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Internally Applied Aerosol Duct Sealant:

1. Sealant and sealing and testing equipment Manufacturer: Aeroseal, LLC
2. Sealant: Aerosol of 4-10µ particles Vinyl Acetate Polymer
3. Solids content: Minimum 35%
4. Mold and mildew resistant.
5. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
6. Service: Indoor and outdoor (outdoor ducts within continuous external weatherproof jacketing).
7. Service Temperature: Approx. -10 to 450 deg F.
8. Substrate: Sealant shall be compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, aluminum, drywall, poured concrete, concrete masonry block.
9. VOC: Maximum 10.7 g/L (less water).
10. Flammability: Non-flammable. UL 723 Flame Spread = 0, Smoke Developed = 0.
11. Certifications: UL 1381 “Outline of Investigation for Aerosol Duct Sealant”.
12. Seal class: Capable of achieving SMACNA Seal Class A.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the existing ducts that are planned to be sealed and ensure that are cleaned per NADCA (National Air Duct Cleaners Association)

B. Examine the duct construction, and conditions under which work is to be performed to determine the appropriate methods, tools, and equipment required for performance of work.

C. Air duct leaks >5/8” wide found during the pre-work examination of the HVAC distribution system or other conditions detrimental to the performance of the sealing and testing work if

discovered during pre-work examination shall be documented in a written report and submitted to the CHA Authorized Representative.

D. Record and mark settings of controls, dampers, and other directional devices within the HVAC air distribution system, to ensure those components can be returned to those settings at the completion of the HVAC sealing and testing work.

E. Proceed with sealing and testing only after unsatisfactory conditions have been corrected per Aeroseal recommendations and after all HVAC equipment renovation has been completed, but prior to the final balancing of the HVAC systems.

3.2 HVAC AIR DISTRIBUTION SYSTEM SEALING AND LEAK TESTING

A. Duct preparation:

1. Ensure that all debris and significant dust and dirt (>1/8 inch deep) in air distribution system has been removed prior to sealing using a NADCA approved duct cleaning method by others.

2. Temporarily remove or protect from aerosol particles in-duct sensors and controls, fire and smoke sensors as recommended by manufacturer. Restore to initial conditions when sealing and testing work is complete

3. Temporarily disable fire alarms and notify appropriate authorities. Restore to initial conditions when sealing and testing work is complete.

4. Repair all major leakage found during inspection greater than ½ inch wide using mastic and fiberglass mesh tape per SMACNA standards. Mastic and fiberglass mesh tape shall meet UL 181 standards

5. Air Distribution Devices (registers, grilles & diffusers): Remove existing air distribution devices prior to sealing and testing, replace after sealing and testing is complete.

6. Fabricate and place temporary duct blocking to all openings prior to sealing and testing work. Restore to initial conditions when sealing and testing work is complete.

7. Fans, air handling/moving equipment, or other terminal devices shall be isolated from aerosol sealant stream. Restore to initial conditions when sealing and testing work is complete.

8. Contractor shall clean-up any sealant residue that may have adhered to surfaces in occupied areas using manufacturer recommended procedures and materials once testing and sealing work is complete.

9. Contractor shall dispose properly offsite all materials used in and any debris generated from sealing and testing.

B. Containment:

1. Protect occupied spaces from aerosol particles using manufacturer approved procedures. Particle overspray from sealing shall be collected and precautions must be taken to ensure that particles are not dispersed outside the HVAC system being sealed during the sealing process.

2. Aerosol Particle Collection: Contractor shall use air scrubbing equipment equipped with minimum MERV 14 Standard 52.5 Minimum Efficiency Reporting Value filters to capture/contain sealant particle overspray.

C. Sealing Methods:

1. Seal existing ductwork from the inside using automated aerosolized sealant injection. Use sealing methods approved by the Aerosol Sealant Manufacturer.

D. Verification:

1. Verification of HVAC air distribution system initial and final air leakage levels shall be determined by pressurized duct leak test before and after sealing. Final HVAC air distribution system air leakage level shall not exceed 3% of exhaust fan or make-up air unit design volume flow rate at a test pressure as specified by engineer of record. Test pressure shall not exceed the SMACNA Duct Construction Pressure Rating for the duct being tested. If a test pressure is not specified, contractor shall record initial and final leakage at a test pressure = 1.5" w.g. Contractor shall leak test ductwork that has been sealed using Aeroseals approved by the manufacture.

2. Air-Volume Control Devices: Existing dampers and any-directional mechanical devices inside the HVAC system that are to remain upon completion of sealing and testing work must be restored to their initial marked position if damper or device position has been moved.

E. Service Openings:

1. Utilize the existing openings already installed in the HVAC system where possible.

2. Other access points shall be provided, where required, and shall be sealed in accordance with industry codes and standards. Refer to Division 23 Sections "Metal Ducts" and "Ductwork Accessories."

3. Closures must not significantly hinder, restrict, or alter the air-flow within the system.

4. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within insulated systems.

5. Openings must not compromise the structural integrity of the system.

6. Construction techniques used in the creation of openings shall conform to requirements of the authority having jurisdiction and applicable NFPA, SMACNA and NADCA standards.

7. Cutting service openings into flexible duct is not permitted.

END OF SECTION

SECTION 23 01 51

STEAM AND HOT WATER BOILER RENOVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes renovation of steam boilers (15 PSIG and under) and hot water boilers with the following scope:

1. Force Draft Gas burner.
2. Boiler Trim.
3. Boiler Burner controls.
4. Boiler Repairs.
5. Instrumentation and control panel.

1.2 DEFINITIONS

A. NWL Normal water level

B. LWCO Low Water level Cut Out

C. BHP Boiler horsepower

1.3 SUBMITTALS

A. Submit manufacturer's data in accordance with Division 01 section "Submittal Procedures."

B. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

C. Shop Drawings: For force draft burners, boiler trim, and accessories. Include plans, elevations, sections, details, access clearances, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Elevations for the boiler level control and safeties including top of tube.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boiler burners, components, and accessories to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Other Informational Submittals:

1. Startup Reports: Submit reports documenting the activities performed. These reports are to be submitted two weeks after the startup is completed.
2. Training Reports: Submit reports on training documenting dates and attendance.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Award the boiler renovation work to a single firm that is specialized in the renovation of steam and hot water boilers, that has not less than 5 years experience renovating boilers similar in extent to that required for the Project, that has organized quality control procedures, that has successfully renovated work similar in design and extent to that required for the Project, in not less than three projects of similar scope, and whose work has resulted in construction with a record of successful in-service performance.

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. Provide firebox boiler ancillary electrical components that are listed and labeled by UL.

D. Regulatory Requirements: Boiler renovation work shall be performed in accordance with the Chicago Building Code.

E. Any repair work on the boiler pressure vessel shall be performed by contractors with certifications from Hartford and National Board.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and store components in manufacturer's original protective packaging, with seals and identifying labels intact.

B. Store components indoors, in a clean and dry location, and in a manner to avoid damage to the components.

1.6 COORDINATION

A. Coordinate boiler renovation with the Owner and control of the boilers with the building automation system.

1.7 WARRANTY

A. Warranty: Manufacturer's standard form, executed by manufacturer and Installer, in which manufacturer and Installer agree to replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion / Preliminary Acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. Forced Draft Burner:

a. Cleaver Brooks.
b. Industrial Combustion.
c. Powerflame.
d. Webster.

2. Burner Management Controls:

a. Honeywell.
b. Siemens.

2.2 STEAM BOILER RENOVATION

A. Boiler Accessories:

1. Remove and Replace:

a. Handholes for water-side inspections and gaskets.
b. Blowdown lines and valves from boiler to main header. Blowdown valves for both bottom blowdown lines and the surface blowdown line.
c. Replace the manway cover and gaskets.

2. Front and Rear Doors/Covers:

a. Remove and replace gasket material per manufacturer's recommendation and repair or replace any damaged or broken studs.

3. Provide new flue-gas thermometer having a minimum 3-1/2-inch diameter dial.
4. Insulation:

a. Replace damaged insulation with the same thickness and material as the existing insulation. Encapsulate insulation with aluminum jacket to match existing jacketing.

2.3 HOT WATER BOILER RENOVATION

A. Remove and Replace:

1. Handholes for water-side inspections and gaskets.
2. Manway cover and gaskets

B. Install new flue-gas thermometer having a minimum 3-1/2-inch diameter dial.

2.4 FORCED DRAFT BURNER REPLACEMENT (STEAM AND HOT WATER BOILERS)

A. Burner: Forced draft, full modulating, welded construction with multivane, stainless-steel, flame-retention diffuser for natural gas (1000 BTU/CF). Minimum 5:1 turndown.

1. Boiler/burner combustion efficiency shall meet or exceed ASHRAE 90.1-2010.
2. The lowest allowable firing rate shall produce a leaving flue gas temperature of 300 deg F based on inlet combustion air at 80 deg F.
3. Full fire combustion shall not produce a flame that will contact any furnace surface.

B. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

1. Motors: Comply with requirements specified in Division 23 Section, "Common Motor Requirements for HVAC Equipment."

a. 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.

C. Gas Train: Control devices and modulating control sequence shall comply with requirements in ASME CSD-1, IRI. Provide Honeywell/ITT Hydrometor gas shutoff valves and manual shutoff valves. Gas trains 3-inches and larger will be flanged construction.

D. Pilot gas train to include solenoid shutoff valve and manual ball type shutoff valves.

E. Gas pressure available at gas train inlet = **<Insert text>**.

F. Provide gas pressure regulator as required to step down building gas pressure to maximum gas train inlet pressure.

G. Pilot: Interrupted-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

H. Burner inlet silencer.

I. Control: The burner air louvers and a butterfly type fuel gas valve on each boiler-burner unit shall be operated simultaneously by a modutrol motor controlling both fuel and air supply by means of a characterized linkage cam assembly. The fuel air drive shall be provided with a position indicating switch which shall be inter-locked with the flame safeguard system, to assure starting in the low fire position. Each burner shall have automatic modulation from a separate operating control. Provide in each boiler control panel a manual/automatic switch and potentiometer, for manual control of the firing rate from 15 percent to 100 percent of rated capacity over the full firing range.

J. Safety: Burner shall be equipped with a complete system of safety devices, including the electronic flame safeguard control with pre- and post-purge. Pre-purge shall be a full open purge of sufficient time to provide four air change ignition purges of the combustion chamber or a full 30-second duration pre-purge. All controls shall be approved by UL.

K. Burner shall burn the specified quantity of gas fuel without objectionable vibrations, noise or pulsation, with not more than 20 percent excess air and no CO in the products of combustion as determined by an Orsat Analyzer.

L. Interlock Control Requirements:

1. The boiler manufacturer will furnish all required control interlocks between the boiler-burner and related equipment as herein specified and as follows:

a. Contacts as required for all remote alarms.
b. Relays for remote boiler room combustion air dampers.
c. Contacts for remote enable/disable of boiler-burner.
d. Provide emergency door shut off switch, to shut off gas supply to burner.
e. Shut off gas supply to burner when the room ambient temperature is above 210 deg F.

2.5 TRIM FOR HOT WATER BOILERS

A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."

B. Low water cut offs (UL listed). Low shall be electronic probe type.

C. Aquastat Controllers: Operating, firing rate, and high limit and manual reset.

D. Safety Relief Valve(s): ASME rated.

E. Pressure and Temperature Gage: Minimum 3-1/2-inch diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is approximately 50 percent of full range. Provide gauges at the inlet and outlet of the water connections to the boiler.

F. Boiler Air Vent: Automatic.

G. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.6 BOILER/BURNER CONTROLS (HOT WATER BOILERS)

A. The contractor shall provide control panel(s) to contain all required digital, electronic, hard wire relays, terminals, switches, indicating lights, etc. securely and conveniently mounted on the boiler/burner.

B. The boiler/burner controls shall be UL listed and labeled and in conformance with ASME CSD-1.

C. The burner controls will be designed and constructed to meet the requirements of Factory IRI, Underwriter's Laboratory and CSD-1.

D. Relays and connections for operation of a combustion air damper and remote boiler trouble alarm. Connections will also be provided for emergency shutdown of the boiler.

E. Alarm bell with silencing pushbutton mounted on the burner control panel and arranged to sound on all non-recycling boiler shutdown conditions.

F. The burner management system shall be Fireye E300 with an ED510 or Honeywell S7830.

1. No momentary power loss, voltage or frequency loss shall cause the Fireye 300 to shut down requiring manual reset.

G. Control Panel:

1. Factory pre-wired control panel shall be supplied with each boiler-burner unit.
2. The panel shall be field mounted on the boiler.
3. The burner panel shall meet Nema 12 compliance complete with a cylinder lock.
4. Panel shall have a dust gasket seal on the entire inner door edge.
5. The panel shall contain the following:

a. The flame safeguard shall be a Fireye YB110 or a Honeywell Model RM7800, complete with a through the panel door, view window.
b. The flame safeguard system shall include an expansion module to monitor the status of all safeties on the boiler.
c. The expansion module shall be a Fireye Y2 300 or Honeywell S7830 with S7800A Display Module.
d. The expansion module will monitor the status of the following inputs: primary and secondary low water cutouts, high water temperature, operating control, low air switch, low gas pressure, high gas pressure, combustion air damper, and failure of air-fuel ratio controller.
e. Main start switch.
f. Set point adjustment.
g. Operating pressure control (factory wired and mounted to cycle burner).
h. Burner motor starter with overloads.
i. Control transformer.
j. Fuses.
k. Control switch.
l. Indicating lights.

1) Each panel shall have eight (8) indicating lights: Power, Call for Heat, Main Fuel, Pilot Failure, Main Flame Failure, Limit Failure, and Low Water.

m. 4 inch alarm bell with automatic reset silencing mechanism, to ring on flame failure, pilot failure, or limit failure.
n. Shut down due to excessive ambient air temperature, high steam pressure, flame failure or pilot failure shall require manual reset.
o. All wiring to be number coded at every termination. Numbering system to be professionally printed on heat-shrink tubing at the point of connection.
p. Wiring diagrams shall clearly indicate wiring numbers and termination points. Liquid tight shall be used throughout.
q. Provide separate contacts for a remote alarm.
r. Provide combustion air damper relay.

6. Separate factory installed terminal strip dedicated for interface to EMS (Energy Management System) control and monitor points. Points required – control power to open combustion air damper, boiler enable/disable, status, burner modulation, low water, steam pressure adjustment and boiler failure. See Division 23 Section, "Digital Control Systems for HVAC - Sequence of Operation," for complete requirements.

7. Burner modulation interface to allow EMS to modulate burner-firing rate through an analog signal of 0-10VDC or 4-20ma.
8. Panel mounted selector switch to select burner modulation from either internal boiler controls or EMS. Controls shall automatically revert back to internal burner modulation upon failure of BAS.
9. Factory installed Hand-Off-Automatic switch for interface to EMS. When operating in the Hand position the burner modulation will be via internal boiler controls.
10. Low-Water Cutoff and Pump Control: [Operate feed water pump(s) continuously and modulate valve for makeup water control.
11. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
12. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

    a. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design pressure.
    b. Low-Water and Low-Low-Water Cutoff Switches (UL, CSD-1): Float and electronic probe shall prevent burner operation on low and low-low water. Low cutoff switch shall be automatic-reset type, low-low water shall be manual-reset type.
    c. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

13. Common Failure output to signal the EMS when any safety or condition shuts down the boiler.
14. Low fire hold control with minimum temperature standby control and standby-operate switch.
15. Power disconnect switch installed in the burner control panel.
16. A ladder diagram of the boiler/burner controls laminated permanently on the inside panel door.
17. All terminals shall be uniquely identified with an alphanumeric sequence.
18. All wires shall be uniquely identified with an alphanumeric sequence.
19. A clear distinction shall be made of wiring to non-boiler vendor devices.

H. Provide a 12-point terminal strip for external permissive interlocks.

I. Other hardware requirements shall include:

1. Control circuit transformer if required and sized for three times (3x) the apparent load.
2. Magnetic contactors rated at 100,000 cycles.
3. Current - limiting fuses rated at 1255 of circuit or device load and 200,000 ampere interrupting capacity.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect burners before shipping, according to applicable codes.

B. Burner Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler renovation, examine existing piping and electrical connections to verify actual conditions affecting boiler performance, maintenance, and operations.

3.2 BOILER RENOVATION

A. Replace gas fired boiler components in accordance with NFPA 54.

B. Replace the existing forced draft burner and the controls.

C. Replace and install new boiler trim.

D. Replace all electrical devices for the boiler.

E. Replace all control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Install gas piping in accordance with Division 33 Section, "Natural Gas Piping."

B. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

C. Ground equipment according to Division 26.

D. Connect wiring according to Division 26.

3.4 CONTRACTOR STARTUP AND REPORTING

A. Contractor Tests and Inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
    b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and steam pressure.
    c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Remove and replace malfunctioning units and retest as specified above.

C. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections.
2. Provide written certification to the Architect and Engineer of Record that the installation conforms to the manufacturer's requirements.
3. Provide an initial burner set-up combustion efficiency report to the Architect of Record. Include in Report:

    a. Date.
    b. School name.
    c. Ambient temperature (deg F).
    d. Boiler room temperature (deg F).
    e. Boiler room pressure compared to ambient (inches w.g.).
    f. Stack draft at boiler (inches w.g.).
    g. Furnace draft (inches w.g.).
    h. Actual stack temperature (deg F).
    i. Percent carbon monoxide and percent oxygen in flue gas.
    j. Gas consumption, clocked from gas company meter.

4. Provide a final burner set-up combustion efficiency report when the ambient temperature is less than 25 deg F to the Architect of Record.
5. Provide on two separate occasions two hours of instruction to the site personnel.

3.5 CONTRACTOR STARTUP AND REPORTING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Video training sessions. Refer to Division 01 Section "Demonstration and Training." Startup service shall include the testing, inspections and startup test reports.

3.6 DEMONSTRATION AND COMMISSIONING

A. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining chillers. 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.

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. If the IOM does not include a written troubleshooting guide one will be provided.

C. Schedule training with Owner, through Architect, with at least seven days' advance notice.

D. 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 01 and 23.

END OF SECTION

SECTION 23 05 03

GENERAL PROVISIONS FOR HVAC WORK

PART 1 - GENERAL

1.1 SUMMARY

A. The work under Division 23 "Heating, Ventilating, and Air Conditioning (HVAC)" shall include all labor, services, materials and equipment and performance of all work required for the installation of all mechanical work as shown on the Drawings and herein specified in the following Sections.

B. Should there be any discrepancies or a question of intent, refer the matter to the Architect/Engineer for decision before ordering any equipment or materials or before starting any related work.

C. Where work connects to that of another trade, or to piping or equipment in place, take measurements in the field to make connecting work come true and line up with the item being connected.

D. Where work specified under other Divisions of the Specifications connects to equipment which is a part of Division 23, provide proper connection(s) to such equipment.

E. Minor items and accessories or devices reasonably inferable as necessary, to the complete and proper installation and operation of any system, shall be provided by the Trade Contractor for such system whether or not they are specifically called for by the Specifications or Drawings.

F. The Drawings and Specifications are to be taken together. Work specified and not shown or work shown and not specified shall be performed or furnished as though mentioned in both Specifications and Drawings. If there is a discrepancy between the Drawings and Specifications as to the quantity or quality to be provided, the greater quantity or the better quality shall be provided.

1.2 DEFINITIONS

A. "Piping" includes, in addition to pipe, all fittings, valves, hangers, and other supports and accessories related to such piping.

B. "Ductwork" includes, in addition to ducts, all fittings, transitions, dampers, hangers and other supports and accessories related to such ductwork.

C. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction, in crawl spaces or buried.

D. "Exposed" means not installed underground or "concealed" as defined above.

E. "Invert Elevations" means the elevation of the inside bottom of pipe or duct.

F. "HVAC Work" is all of the work in Division 23.

1.3 QUALITY ASSURANCE

A. Each major component of equipment to have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place.

B. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

C. All equipment provided under Division 23 to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any equipment, as determined by the Owner's Representative or Architect/Engineer to be producing objectionable noise or transmitting noise or vibration to the building to be repaired or removed and replaced.

D. All workmanship shall be first class in every respect and shall be performed only by skilled mechanics.

E. Shutdown and Notifications:

1. It is imperative that service interruptions on the various existing utilities be held to an absolute minimum. Wherever possible provide suitable temporary services or connections, where continuity of service for essential systems can be maintained by this means. It will be the Owner's final prerogative to decide which systems are to be considered as essential, and to establish the maximum allowable shutdown time, if any, for each system.
2. Owner will require not less than 72 hours advance notice, in writing, that an interruption of service in any system is desired. Such notice shall identify the system or systems involved, and shall be submitted in duplicate, one copy of which will be signed and returned by the Owner's authorized representative stating whether the requested shutdown will be permitted or not.

F. Existing Utilities:

1. Location of utilities as shown on the drawings has been determined from the best available information and is given for convenience; however, Owner does not assume responsibility in the event that during construction, utilities other than those shown may be encountered, and that the actual location of those which are shown may be different from the location as shown on the plans.
2. Assume responsibility for interference with or damage to any existing utilities, and repair or replace same with the least possible delay.

G. Notify Architect of broken or open pipes discovered during construction.

H. Layout and establish the lines and levels necessary for work.

I. The following Standards shall be used where referenced by the following abbreviations:

1. AABC: Associated Air Balance Council
2. ADC: Air Diffusion Council
3. AGA: American Gas Association
4. AIA: American Institute of Architects
5. AMCA: Air Moving and Conditioning Association

6. ANSI: American National Standards Institute
7. ARI: Air Conditioning and Refrigeration Institute
8. ASE: Association of Safety Engineers
9. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers
10. ASME: American Society of Mechanical Engineers
11. ASPE: American Society of Plumbing Engineers
12. ASTM: American Society of Testing and Materials
13. AWPB: American Wood Preserves Bureau
14. AWS: American Welding Society
15. AWWA: American Water Works Association
16. CSA: Canadian Standards Association
17. CISPI: Cast Iron Soil Pipe Institute
18. EIA: Electronic Industries Association
19. EPA: Environmental Protection Agency
20. FDA: Food and Drug Administration
21. FM: Factory Mutual Insurance Association
22. HIS: Hydraulic Institute Standards
23. IRI: Industrial Risk Insurers
24. IBR: Institute of Boiler and Radiator Manufacturers
25. IEEE: Institute of Electrical and Electronics Engineers
26. MCAA: Mechanical Contractors' Association of America
27. NIST: National Institute of Standards and Testing
28. NEBB: National Environmental Balancing Bureau
29. NEC: National Electric Code
30. NECA: National Electric Contractors Association
31. NEMA: National Electrical Manufacturers Association
32. NFPA: National Fire Protection Association
33. NSC: National Safety Council
34. NSF: National Sanitation Foundation
35. OSHA: Occupational Safety & Health Administration
36. SAE: Society of Automotive Engineers
37. SBI: Steel Boiler Institute Industry
38. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
39. TIMA: Thermal Insulation Manufacturers Association
40. UL: Underwriters' Laboratories
41. USDA: United States Department of Agriculture

J. Project Certification:

1. Each trade shall submit a project certification, guaranteeing that this project was constructed and will operate in accordance with the performance requirements of the Drawings and Specifications. This certification shall be signed by a principal of the firm and shall be delivered to the Architect/Engineer prior to final payment.

K. Drawings:

1. The Drawings are essentially diagrammatic in nature and show general arrangement of the equipment, piping, ductwork, accessories, etc. Because of the small scale of the Drawings, it is not possible to show each offsets, fittings, and accessories, which may be required. Carefully investigate the structural conditions, Architectural Drawings, Equipment Drawings, and the finished conditions of the work and arrange such work

accordingly, furnish any fittings, pipe accessories that may be required to meet such conditions.

2. Any changes from the plans necessary to make the work conform to building as constructed and to fit work of other trades, or to conform to rules of the governing authorities and regulations, shall be met without extra cost to the Owner.
3. The layout of the piping, ductwork, equipment, etc., as shown on the Drawings shall be checked and exact locations shall be determined by the dimensions of equipment approved and Contractor shall obtain the Architect's approval for revised layout before the apparatus is installed. Consult the Architectural, Structural, and Equipment Drawings for the dimensions, locations of partitions, locations and sizes of structural supports, foundations, etc.
4. Refer to the Architectural Plans for details and large scale Drawings and to approved Shop Drawing of equipment furnished under other Contracts or Sections of the Specifications for exact location of service connections. The equipment Shop Drawings will be furnished to the Contractor before roughing in. Contractor shall not install any piping or ductwork for said equipment until they have received approved Coordination Drawings for same.

L. Minor Deviations:

1. The dimensions of equipment hereinafter specified or indicated on the Drawings are intended to establish the outlines and characteristics of such equipment in general. Minor deviations in dimensions will be permitted to allow the manufacturers specified to bid on their nearest stock equipment, provided the specified ratings are met or exceeded.
2. Where manufacturers' catalog numbers or types are mentioned in the Specifications or indicated on the Drawings, they are intended to be used as a guide only and shall not be interpreted as taking precedence over the basic rating and duty specified. In all cases, manufacturers shall verify the duty specified with particular characteristics of the equipment they intend to offer for approval and shall also pay the additional charges as may be required under other Divisions.

M. Interferences:

1. Before making any installation, the work of the trades must be coordinated and the necessary changes shall be made to avoid interferences or improper effect on work to be performed by any other Section. In the event that interferences develop, the Architect's decision will be final and no additional compensation will be allowed for moving of misplaced piping, ducts, conduit and/or equipment.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Unless otherwise specified, all material and equipment incorporated in the work under the contract shall be new.

B. Material and equipment specified by one or more manufacturer's name, trade name and/or model number does not limit a bidder from bidding on other equipment providing the procedure set forth in the Conditions of the Contract and hereinafter specified is followed.

C. The various mechanical systems have been engineered and designed on equipment name and catalog numbers specified or designated on the Drawings.

D. A Contractor who intends to furnish equipment listed as approved equal shall proceed as follows:

1. Obtain Architect/Engineer's approval of said equipment.
2. Be fully responsible for said equipment.
3. Include in the Base Bid, all cost for any changes that may be required in his work and/or work of other trades for the proper installation and functioning of said equipment.

PART 3 - EXECUTION

3.1 ALTERATIONS IN PRESENT BUILDING AND SITE

A. Take particular note of the revisions and alterations of existing services, utilities, etc., due to the new construction as indicated on the Drawings and/or as required by alterations to the existing building.

1. Where necessary, reroute piping, ducts, etc. from within walls, floors, ceilings, etc. being removed. The Trade Contractor involved with the interrupted service shall be responsible for accomplishing the required work whether shown on the Drawings or not.
2. Cap all abandoned or terminated piping, etc. below floor, behind wall surface, above ceiling, etc. as required to be completely concealed after new work is complete.
3. In general, mechanical remodeling work is shown on the Mechanical Drawings but carefully study all Drawings for all contracts for "demolition" and "remodeling" work in the existing buildings and field check to verify locations where such work is being done to determine the exact extent of work required. No extra will be allowed for additional work required because of demolition or remodeling whether or not work is specifically noted, itemized or shown on the Drawings.
4. Maintaining of Present Services: Maintain all services in the existing building. This shall include all temporary or permanent piping connections, etc., required to provide and maintain services to the present buildings and the equipment served. In the case of change over piping and ductwork or where new service connections are to be made to existing services and service interruptions can in no way be avoided, the service interruptions shall be with the minimum of inconvenience to the Owner. If the Owner’s Representative directs that such work be performed during premium time hours then the Contractor shall be reimbursed for the premium time portion of the direct labor cost of the workmen actually performing the work. All costs (except for premium time portion of labor costs) incurred in order to comply with the foregoing shall be included in the Contractor's original bid for the work and without additional costs to the Board.
5. Remove or reroute, as required, all services at existing buildings to be demolished.

3.2 DISPOSITION OF REMOVED EQUIPMENT

A. Where existing materials or equipment are specified to be removed from service, the Trade Contractor shall take possession of same and remove them from the site promptly, except as specified below or unless otherwise noted on Drawings.

B. All salvageable material and equipment, including but not necessarily limited to, electrical fixtures, conduit, wiring, plumbing fixtures, heating units, piping, valves, etc., shall be removed and maintained in as good condition as possible and turned over to the Owner. However, if the Owner decides any such materials are of no value, then they shall become the property of the Contractor who shall remove such discarded work from the premises and dispose of same.

C. Existing equipment or systems, etc. which are specified to be replaced by new equipment, or systems, etc. shall not be removed from service until the new equipment, materials, systems, etc. have actually arrived at the project site.

3.3 INSTALLATION

A. Each Trade Contractor shall be responsible for all of his work fitting into place in a satisfactory and neat workmanlike manner acceptable to the Architect/Engineer.

B. Confer with other Trade Contractors regarding the location and size of pipes, equipment, fixtures, conduit, ducts, openings, switches, outlets, etc., in order that there may be no interference between the installation of the progress of the work of any Trade Contractor on the project. The Architectural Drawings shall take precedence over the Mechanical and Electrical Drawings.

C. The Mechanical Drawings are diagrammatic and shall be followed as closely as actual construction of the building and the work of other trade contractors will permit. All changes from Drawings necessary to make the work of each Contractor conform to the building construction and the work of other trade contractors shall be done at the appropriate Trade Contractor's expense.

D. Unless explicitly stated to the contrary, each Trade Contractor shall furnish and install each item of equipment or material hereinafter specified, complete with all necessary fittings, supports, trim, piping, insulation, etc., as required for a complete and operating installation.

E. All equipment and materials shall be installed according to the manufacturer's instructions unless otherwise specifically directed by the Trade Contract Documents. All piping, valves, connections, and other like items recommended by the manufacturer or required for proper operation shall be provided without additional cost to the Board.

F. All references to Contractors in Specifications and Drawings shall refer to the respective Trade Contractor performing that portion of the work.

G. In general, all piping, ductwork and similar items shall be installed concealed from view above the ceiling, in partitions, shafts, chases, unless otherwise indicated.

H. Locations of items not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site, subject to review.

I. Where pipes are in partitions, furred out spaces and chases, obtain information as to their exact location and size and install work so as to be entirely concealed in the allotted space. If conflicts arise making this impossible, obtain instructions from the Architect/Engineer before proceeding with the work.

J. Wherever two or more pipes are to be installed in parallel, or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and servicing.

K. Furnish advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit installation of other work without delay.

L. Where there is evidence that parts of the Mechanical Work will interfere with other work, assist in working out space conditions and/or the structure, make necessary adjustments to accommodate the work.

M. Mechanical Work installed before coordinating with other work so as to cause interference with other work shall be changed to correct such condition without additional cost to the Owner.

N. In no case shall any pipe, conduit, duct, or item of equipment be installed where it is supported on or suspended from another pipe, conduit, duct or item of equipment.

O. Where an item or task is specified to be provided "under this Section," it shall be understood that, that item or task is the responsibility of the trade responsible for that Section, but the work must be performed by qualified workmen of the appropriate trade.

P. Accessibility:

1. Install Mechanical work to permit removal (without damage to other parts) of coils, heat exchangers, pumps, fan shafts and wheels, belt guards, sheaves and drives, and other parts requiring periodic replacement or maintenance.
2. Arrange pipes, ducts, and equipment to permit ready access to valves, cocks, traps, starters, motors, dampers, control components, and to clear the openings of swinging and overhead doors and of access panels.
3. Change dimensions of ductwork when required to meet job conditions but maintain the same equivalent cross-sectional area. Based on equal friction to airflow.
4. Provide access panels in equipment, ducts, and like items for inspection of interiors and proper maintenance.

END OF SECTION

SECTION 23 05 05

BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Concrete base construction requirements.
3. Escutcheons.
4. Dielectric fittings.
5. Mechanical sleeve seals.
6. Equipment nameplate data requirements.
7. Nonshrink grout for equipment installations.
8. Field-fabricated metal and wood equipment supports.
9. Installation requirements common to equipment specification sections.
10. Mechanical demolition.
11. Cutting and patching.
12. Touchup painting and finishing.
13. Access Panels
14. Bearings
15. Drives
16. Flashings
17. Cleaning

B. Pipe and pipe fitting materials are specified in Division 22.

1.2 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, crawl spaces, 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.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:

1. BS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. CR: Chlorosulfonated polyethylene synthetic rubber.
4. EPDM: Ethylene-propylene-diene terpolymer rubber.
5. NBR: Acrylonitrile-butadiene rubber.
6. PE: Polyethylene plastic.
7. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

A. Refer to Division 01 Section "Submittal Procedures" for administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

B. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, access panels and identification materials and devices.

C. Coordination Drawings: For access panel and door locations.

D. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Use BIM software for coordination. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement.
2. Planned duct systems layout, including elbow radii and duct accessories.
3. Clearances for installing and maintaining insulation.
4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
5. Equipment and accessory service connections and support details.
6. Exterior wall and foundation penetrations.
7. Fire-rated wall and floor penetrations.
8. Sizes and location of required concrete pads and bases.
9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
10. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
11. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
12. Access panel locations in ceilings/walls/floors.

1.4 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. American Society for Testing and Materials

a. ASTM A 53-98: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
b. ASTM B 32-96: Specification for Solder Metal
c. ASTM B 813-93: Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
d. ASTM B 828-98: Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
e. ASTM C 1107-97: Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
f. ASTM C 1173-97: Specification for Flexible Transition Couplings for Underground Piping Systems
g. ASTM D 1785-96b: Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
h. ASTM D 2235-96a: Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
i. ASTM D 2564-96a: Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
j. ASTM D 2672-96a: Specification for Joints for IPS PVC Pipe Using Solvent Cement
k. ASTM D 2855-96: Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
l. ASTM D 3139-98: Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
m. ASTM F 402-93: Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermostatic Pipe and Fittings
n. ASTM F 493-97: Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
o. ASTM F 656-96a: Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

2. American Water Works Association

a. AWWA C110-98: Ductile-Iron and Gray-Iron Fittings, 3 In. through 48 In. (76 mm through 1219 mm), for Water and Other Liquids
b. AWWA C219-97: Bolted, Sleeve-Type Couplings for Plain-End Pipe

3. American Welding Society

a. AWS A5.8-92: Specification for Filler Metals for Brazing and Braze Welding
b. AWS D1.1-98: Structural Welding Code--Steel
c. AWS D10.12-89: Recommended Practices and Procedures for Welding Low Carbon Steel Pipe
d. Brazing Handbook. 1991.

4. ASME International

a. ASME B1.20.1-83 (Reaffirmed 1992): Pipe Threads, General Purpose (Inch)
b. ASME B16.21-92: Nonmetallic Flat Gaskets for Pipe Flanges
c. ASME B18.2.1-96: Square and Hex Bolts and Screws--Inch Series
d. ASME B31 Series: Code for Pressure Piping

e. 1998 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"

5. Copper Development Association Inc.

a. Copper Tube Handbook. 1995.

6. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

a. MSS SP-107-91: Transition Union Fittings for Joining Metal and Plastic Products

B. Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.5 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.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate phasing and sequencing of all work with the Owner and Building Engineer.

B. Coordinate mechanical equipment installation with other building components.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Coordinate installation of required supporting devices and sleeves in poured-in-place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

H. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

I. Coordinate connection of electrical services.

1.7 WARRANTY

A. Provide warranty on materials and labor for 30 months starting from date of delivery, or two years 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. Dielectric Unions: No preference.
2. Dielectric Flanges: No preference.
3. Dielectric-Flange Insulating Kits: No preference.
4. Dielectric Couplings: No preference.
5. Dielectric Nipples: No preference.
6. Mechanical Sleeve Seals:

    a. Calpico, Inc.
    b. Metraflex Co.
    c. Thunderline/Link-Seal.

7. Metal, Flexible Connectors:

    a. Grinnell Corp.; Grinnell Supply Sales Co..
    b. Mercer Rubber Co.
    c. Metraflex Co.

8. Rubber, Flexible Connectors:

    a. General Rubber Corp.
    b. Metraflex Co.

c. Red Valve Co., Inc.

9. Grooved Fittings:

a. Grinnell Corp.; Grinnell Supply Sales Co.
b. Victaulic Company of America.
c. Central Sprinkler.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, 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.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 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: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: 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. 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: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

1. 2-Inch NPS and Smaller: Threaded.
2. 2-1/2-Inch NPS and Larger: Flanged.
3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.

B. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose. Do not use for potable water.

C. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose. Do not use for potable water.

D. Couplings may be used to provide allowance for controlled pipe movement, expansion, contraction, and or deflection to absorb movement for thermal changes, setting or seismic action and also vibration attenuation.

2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Remove and cap all inactive or abandoned piping and ductwork in mechanical rooms. Larger duct and pipe located in accessible areas shall be removed and capped at the discretion of the contractor with concurrence of Owner and Building Engineer.

C. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated on the drawings to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

D. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Select system components with pressure rating equal to or greater than system operating pressure.

C. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

2. Existing Piping: Use the following:

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.3 PAINTING AND FINISHING

A. Refer to Division 09 Section "Painting" for paint materials, surface preparation, and application of paint.

B. Do not paint piping specialties with factory-applied finish.

C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.5 ERECTION

A. Provide all necessary rigging, scaffolding, tools, tackle, labor and other like items necessary for the complete installation of the equipment.

B. Adapt his work to job conditions and install his work to clear beams, joists and light fixtures, adjusting risers, avoiding interferences with windows and openings, raising or lowering work to permit the passing of ductwork or the work of other trades, all as required or as job conditions dictate, without additional costs to the Owner.

C. Trade Contractor shall not rig, tie to, or rest weight upon any part of the building or make use of any stairway until specific permission is obtained.

1. Permission to rig to or make use of any part of the building premises shall not relieve the contractor of responsibility for any damage.

D. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without

splitting wood members.

C. Attach to substrates as required to support applied loads.

3.7 FLASHINGS

A. Openings in roof shall be flashed with 40 lb. sheet lead, in one piece, extending 24" under roofing in all directions from drains, pipes, or ducts, with upper edge at least 8" above the roof and turned over and down into increaser or sleeve or over curb for at least 1" and tightly bound with nonferrous wire.

1. All lead flashings shall be entirely painted with a good coat of black asphaltum before installation.

2. Roof flashing must be approved in writing by the Roofing Trade contractor to the effect that such flashing will not void guarantees or bonds pertaining to the roofing contract.
3. Coordinate with the work under Division 07.

3.8 OPENINGS

A. Where temporary openings are necessary thru walls and partitions of the building for the entry or installation of tanks, fans, or other machinery or apparatus, or for driveways and other facilities, the permanent work of the mechanical trades at said openings shall be temporarily omitted and installed after equipment is brought into the building or after temporary facilities are removed.

B. Refer to other Sections of the Specifications for framing of openings for ducts, grilles, registers, etc., in walls, partitions, floors, roofs, etc. The trade for each service shall be responsible for locating and providing the proper dimensions for all required openings.

1. Space between ducts and wall or floor openings shall be sealed as specified in Division 07 Section "Penetration Firestopping."

C. No cutting or drilling of any building structural members will be permitted, unless the specific extent and limits are approved, in writing, by the Architect.

D. All openings in the existing structure shall be core drilled with a diamond drill. The use of jackhammers will not be permitted.

E. The Contractor shall notify the Architect if any existing openings are uncovered adjacent to location of a new opening. The new opening shall not be drilled if the existing can be used unless directed by the Architect.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes basic requirements for factory- and field-installed motors.

1.2 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

B. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

1.3 SUBMITTALS

A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; enclosure type and mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.

B. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

1. Each installed unit's type and details.
2. Nameplate legends.
3. Diagrams of power, signal, and control wiring. Provide schematic wiring diagram for each type of motor and for each control scheme.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around field-installed motors. Show motor layout, mechanical power transfer link, driven load, and relationship between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports: Submit written reports documenting the activities required to be performed in PART 3. These reports are to be submitted two weeks after the startup is completed.

G. Operation and Maintenance Data: For field-installed motors to include in emergency, operation, and maintenance manuals.

H. Training Reports: Submit reports on training documenting dates and attendance.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain field-installed motors through one source from a single manufacturer.

B. Product Options for Field-Installed Motors: Drawings indicate size, profiles, and dimensional requirements of motors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. 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.

D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

A. Follow manufacturer's instructions for storage and handling of motors.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:

1. Compatible with the following:

a. Magnetic controllers.
b. Multispeed controllers.
c. Reduced-voltage controllers.

2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
3. Matched to torque and horsepower requirements of the load.
4. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

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 products by one of the following manufacturers:

1. Motors:

a. Baldor.
b. General Electric.
c. Lincoln Motors.
d. Marathon.
e. Reliance.
f. U.S. Motors.

2.2 MOTOR REQUIREMENTS

A. Motor requirements apply to factory- and field-installed motors except as follows:

1. Different ratings, performance, or characteristics for motor are specified in another Section.
2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.3 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase.

B. Motors Smaller Than 1/2 HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected. 208V motors shall be rated for continuous operation at 200V.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

G. 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.

H. Enclosure: Open dripproof.

2.4 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium, as defined in NEMA MG 1.

C. Stator: Copper windings, unless otherwise indicated.

1. Multispeed motors shall have separate winding for each speed.

D. Rotor: Squirrel cage, unless otherwise indicated.

E. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating, unless otherwise indicated.

G. Insulation: Class F, unless otherwise indicated.

H. 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.

I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.

1. Finish: Gray enamel.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Inrush 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: Motors shall be inverter-duty. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Designed with critical vibration frequencies outside operating range of controller output.
2. Temperature Rise: Matched to rating for Class B insulation.
3. Insulation: Class F.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide Aegis shaft grounding rings.

C. Rugged-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with non-hygroscopic material.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

D. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

2.6 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. 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.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.

E. Source Quality Control for Field-Installed Motors: Perform the following tests on each motor according to NEMA MG 1:

1. Measure winding resistance.
2. Read no-load current and speed at rated voltage and frequency.
3. Measure locked rotor current at rated frequency.
4. Perform high-potential test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive field-installed motors 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 motor installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIELD-INSTALLED MOTOR INSTALLATION

A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.

B. Install motors on concrete bases complying with Division 03.

C. Comply with mounting and anchoring requirements specified in Division 23 Section "Vibration Controls for HVAC."

3.3 FIELD QUALITY CONTROL FOR FIELD-INSTALLED MOTORS

A. Prepare for acceptance tests.

1. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.
2. Verify bearing lubrication.
3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
4. Test interlocks and control and safety features for proper operation.
5. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.

B. 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.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical tests and visual and mechanical inspections including optional tests and inspections stated in NETA ATS on factory- and field-installed motors. 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.

3.4 CLEANING

A. Comply with applicable requirements in Division 23 Section "HVAC Equipment Cleaning."

3.5 CONTRACTOR STARTUP AND REPORTING

A. Prepare for acceptance tests.

1. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.
2. Verify bearing lubrication.
3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
4. Test interlocks and control and safety features for proper operation.
5. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.

B. 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.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform electrical tests and visual and mechanical inspections including optional tests and inspections stated in NETA ATS on factory- and field-installed motors. 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.

3.6 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain field-installed motors. Refer to Division 01 Section "Demonstration and Training."

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining chillers. 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 owners personnel during training.
2. 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 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 01 or 23.

END OF SECTION

SECTION 23 05 15

MOTORS - VARIABLE FREQUENCY CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes solid-state, pulse-width modulated, variable frequency controllers and variable frequency drives for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. EMS: Energy Management System.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFC: Variable frequency controller and variable frequency drive.

1.3 PERFORMANCE REQUIREMENTS

A. Design – Environmental: Equipment shall be rated for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Temperature Range, Ambient: 32 deg F to 105 deg F.
2. Relative Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.
4. Conditions: Winter: -10 deg F DB; Summer: 95 deg F DB / 75 deg F WB.

B. Noise: The VFC shall not produce motor noise in excess of the manufacturers published noise standards for 60 Hz operation.

1.4 SUBMITTALS

A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings:

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. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.

2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.
3. Enclosure details including cooling, heating, weatherproof construction for all outdoor equipment VFC's.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For manufacturer and testing agency.

E. Field Quality-Control Test Reports: Submit reports documenting the activities performed. These reports are to be submitted two weeks after startup is completed.

F. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. Include the following:

1. Routine maintenance requirements for VFCs and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. A table listing the installed VFC drives set up parameters, alarm and trip setting.
4. Complete parts list with stock numbers, including spare parts.

G. Training Reports: Submit reports on training documenting dates and attendance.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Award the work to a single firm that specializes in the production of variable frequency drives, with not less than 5 years experience in the production of variable frequency drives similar in design and performance to those required for the Project, and whose work has resulted in a history of successful in-service performance. The manufacturer shall have sufficient production capacity, and have organized quality control and testing procedures, to be capable of producing the equipment required for the Project without causing a delay in the Work. The manufacturer shall maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the Intenational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing.

C. Source Limitations: Obtain all VFCs required for the Project through one source from a single manufacturer. These include drives furnished by packaged equipment manufacturers.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Regulatory Requirements: Comply with the Chicago Building Code, including requirements for components and installation.

F. Comply with IEEE 519-1992, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store VFCs in manufacturer's original protective packaging, with original labels detailing contents intact. Store VFCs indoors, off of ground, under cover, in clean, dry location with uniform temperature and humidity to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 COORDINATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances, including clearances required for maintenance, and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Deliver setting templates in time to allow casting of anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.8 COORDINATION WITH ENERGY MANAGEMENT SYSTEM

A. General: The equipment specified in this Section is required to be interfaced with the Energy Management System (EMS) as specified in Division 23 Section "Building Automation System." Provide all devices, hardware, programming, startup and commissioning required to establish the interface.

B. Coordinate with EMS supplier for their review and acceptance of the communications interface to be provided. Include evidence of the coordination and review process with the required submittals for this Section.

C. Provide a list of all read/write and read-only points available through the user interface. Provide software, hardware or paperwork that the contractor installing the EMS will require in order to accomplish the interface.

D. The equipment supplier is solely responsible for the proper performance of their equipment provided the correct information is provided through the communications interface.

E. Provide a prefunctional checklist, startup checklist and demonstration report to the Engineer, Commissioning Agent, or Board Authorized Representative for acceptance of system.

F. Provide a startup technician on-site during the establishment of the interface. Coordinate this activity with the EMS installer.

G. BACNet or LonWorks compliant manufacturer-provided controls

1. Provide any information necessary to allow the BACNet compliant device to be directly connected to the existing network, and send/receive information to the system installed under Division 23 sections.
2. The EMS shall then read and present the information made available by the equipment manufacturer, and transmit information receivable by the equipment manufacturer. This shall be accomplished by user configuration of point information, but shall not require recompiling or downloading of control programs.

H. Non-BACNet or LonWorks compliant manufacturer-provided controls:

1. Provide programming and hardware necessary to integrate information from the equipment into the EMS.
2. Provide the owner and EMS installer with all documentation necessary to receive point information required by Division 23 sections in a communications method compatible with the EMS.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components or equipment that fail in materials or workmanship within the specified warranty period. Manufacturer's warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer in providing onsite service and repair or replacement.

1. Warranty Period: Three years from the date of Substantial Completion or Preliminary Acceptance.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed in the quantity indicated, in manufacturer's protective packaging, with manufacturer's original labels describing contents intact.

1. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Danfoss.
3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
4. Siemens Energy and Automation; Industrial Products Division.
5. Toshiba International Corporation.
6. Yaskawa.

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; 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. All PWM AC Variable Frequency Drives of 40 hp and above shall be equipped with harmonic mitigation equipment to prevent power system problems resulting from high levels of reflected harmonic distortion. Provide harmonic mitigation for drives less than 40 hp where required to meet IEEE 519.

1. The harmonic mitigation equipment shall treat all of the characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.).
2. The characteristic harmonics shall be suppressed without the need for individual tuning or the requirement to phase shift against other harmonic sources.
3. Harmonic mitigation shall be by passive inductor/capacitor network or internal phase shifting transformer. Active electronic components shall not be used.
4. Power factor shall be 0.98 lagging to 0.95 leading in operating range from full to half load.
5. To ensure compatibility with engine generators, the harmonic mitigation equipment must never introduce a capacitive reactive power (KVAR) that is greater than 15% of its kVA rating.
6. The harmonic mitigation equipment shall not resonate with system impedances or attract harmonic currents from other harmonic sources.
7. The harmonic mitigation equipment in combination with the Variable Frequency Drive shall meet all requirements of IEEE 519 for individual and total harmonic voltage and current distortion. The Point of Common Coupling (PCC) for all voltage and current harmonic calculations and measurements shall be the input terminals of the utility distribution transformer to the harmonic mitigation equipment.
8. Total Harmonic Voltage Distortion (THVD) shall meet the requirements of Table 10.2 of IEEE 519 by not exceeding 5% and by limiting the individual harmonic voltage distortion to less than 3%. These limits shall apply while operating on either utility supply or generator supply when applicable. The harmonic mitigation equipment vendor shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.

9. Total Demand Distortion (TDD) of the current at the input terminals of the utility distribution transformer harmonic mitigation equipment shall not exceed the limits as defined in Table 10.3 of IEEE 519. For Isc/IL ratio < 20, TDD must be less than 5%. For all other Isc/IL ratios, the TDD must not exceed 8% even when Table 10.3 allows for more relaxed limits. For single-phase applications, the TDD must not exceed 12%.
10. The full load efficiency of the harmonic mitigation equipment / VFD combination shall be greater than 96%. The harmonic mitigation equipment itself shall have efficiency no less than 99%.
11. Utilization of a low harmonic AC-to-AC drive which meets IEEE 519 is acceptable in lieu of harmonic mitigation equipment.

C. 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.

D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

E. Unit Operating Requirements:

1. Input ac voltage ranges of 208 V, plus or minus 10 percent or 480 V, plus or minus 10 percent as indicated on equipment schedules.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.2 times the base load current for 60 seconds; 1.8 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.

F. Isolated Control Interface: To allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

G. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 125 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

H. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter over-temperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.

7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor over temperature fault where motor is equipped with RTD.

I. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

J. Automatic Reset/Restart: Attempts three restarts after controller 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 controller, motor, or load.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

L. 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.

M. 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.

N. Input Line Conditioning: dc bus link reactors, isolation transformers, active and passive harmonic filters, and phase shifting transformers.

O. VFC Output Filtering: Line inductors, output limit filters, sine wave filters, and motor termination filters shall be provided where the motor to drive conductor lengths exceed manufacturer's recommended lengths.

P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

Q. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).

6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

S. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the EMS or other control systems:

    a. 0 to 10-V dc.
    b. 0-20 or 4-20 mA.
    c. Potentiometer using up/down digital inputs.
    d. Fixed frequencies using digital inputs.
    e. RS485.
    f. Keypad display for local hand operation.

3. Output Signal Interface:

    a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hz).
        2) Output current (load).
        3) DC-link voltage (VDC).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

    a. Motor running.
    b. Set-point speed reached.
    c. Fault and warning indication (overtemperature or overcurrent).
    d. PID high- or low-speed limits reached.

T. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via EMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

U. Integral Disconnecting Means: NEMA AB 1, molded-case switch with lockable handle.

V. Operation and Maintenance Features:

1. Current-Voltage-Frequency Indicating Devices: Mount meters or digital readout device and selector switch flush in controller door and connect to indicate controller output.

2. Manual Bypass: Magnetic contactor arranged to safely transfer the motor from the controller to the power line, or from the line to the controller while the motor is at zero speed. Include VFC-bypass selector switch and indicator lights to indicate mode selection. The operator shall have full control of the bypass starter by operation of the selector switch.
3. Integral Main Disconnect: Circuit breaker connected to shut down all power to both the controller and the bypass. Interlock breaker with cabinet door.
4. Auxiliary Motor Contactors: Electrically interlocked. One contactor connected between the controller output and the motor, controlled by the controller regulator; and one between the bypass power line and the motor, providing across-the-line starting capability in the bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.
5. Isolating Circuit Breaker: Arranged to electrically isolate the variable-speed controller to permit safe trouble-shooting and testing of the controller, both energized and de- energized, while the motor is operating in the bypass mode.
6. Form C output contacts for run and fault conditions.
7. Terminal strip for N.C. safety shutdown contacts.
8. N.C. input for remote start/stop control in Auto mode.

2.3 ENCLOSURES

A. Indoors: NEMA 250, Type 1.

B. Outdoors: NEMA 3R.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Standard Displayed information, display shall be interchangeable for all VFCs installed:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).
8. Fault history with analytical data.

E. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.

4. Fault log, maintaining last four faults with time and date stamp for each.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

2.5 FINISH

A. Finish: Manufacturer's standard paint finish, applied to factory-assembled and -tested VFCs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs 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 VFC installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Harmonic Analysis: Obtain the electrical system one-line diagram from the contract document, provide a harmonic analysis demonstrating that the proposed VFDs (along with harmonic mitigation equipment provided) conform with IEEE 519-1992, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

3.3 SELECTION

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

B. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

C. Select horsepower rating of controllers to suit motor controlled.

3.4 INSTALLATION

A. Anchor each VFC 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.

B. Install VFCs on concrete bases.

C. VFD's are not to be installed inside air handlers or air plenums due to the potentially high humidity or temperatures.

D. VFC's for equipment mounted outdoors shall be mounted in manufacturer approved enclosure for a weather proof location. Include provisions for restricting overheating, low temperatures and condensation build up in enclosure.

3.5 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

3.6 IDENTIFICATION

A. Identify VFCs, components, and control wiring according to Division 23 Section "Mechanical Identification."

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.7 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices according to Division 26 sections. Power and control wiring shall not be run in the same conduit, and shall follow manufacturer's recommendations.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors. Note: VFC's serving multiple motors require special wiring to BAS from individual motor overloads to allow alarming when only one motor fails.

3.8 CONNECTIONS

A. Install conduit and ground equipment in accordance with Division 26 sections.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

B. Include (4) hours per VFC with a maximum of (16) hours spread over (4) instances for readjustment of drives after substantial completion at the direction of the EOR.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Testing and Inspection."

B. Conduct a minimum of 4 hours of training in operation and maintenance of each type of equipment.

C. Schedule training with at least seven days' advance notice.

3.11 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.

3.12 CONTRACTOR STARTUP AND REPORTING

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, 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 controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Prepare written reports.

D. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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.

3.13 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air handling units.

1. Train Owner's maintenance personnel on procedures and schedules for starting up 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 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 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 shall 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 Owner's designated 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 Divisions 01 and 23 sections.

END OF SECTION

SECTION 23 05 16

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-bellows expansion joints.
2. Expansion compensators.
3. Rubber expansion joints.
4. Flexible-hose expansion joints.
5. Packed slip expansion joints.
6. Flexible ball joints.
7. Pipe bends and loops.
8. Alignment guides and anchors.

1.2 DEFINITIONS

A. BR: Butyl rubber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Welding certificates.

C. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

D. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."

1.5 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Subject to compliance with requirements, provide products by one of the following:

1. Metal Bellows Expansion Joints:

   a. Hyspan Precision Products, Inc.
   b. Metraflex, Inc.
   c. Piping Technology & Products, Inc.
   d. Senior Flexonics, Inc.; Pathway Division.

2. Expansion compensators:

   a. Flex-Weld, Inc.
   b. Hyspan Precision Products, Inc.
   c. Metraflex, Inc.
   d. Senior Flexonics, Inc.; Pathway Division.

3. Rubber expansion joints:

   a. Mason Industries, Inc.; Mercer Rubber Co.
   b. Metraflex, Inc.
   c. Senior Flexonics, Inc.; Pathway Division.

4. Flexible-hose expansion joints:

   a. Flex-Hose Co., Inc.
   b. Flexicraft Industries.
   c. Metraflex, Inc.

5. Packed slip expansion joints:

   a. Adsco Manufacturing, LLC.
   b. Advanced Thermal Systems, Inc.
   c. Hyspan Precision Products, Inc.

6. Flexible ball joints:

   a. Advanced Thermal Systems, Inc.
   b. Hyspan Precision Products, Inc.

7. Alignment guides and anchors:

   a. Hyspan Precision Products, Inc.
   b. Metraflex, Inc.
   c. Piping Technology & Products, Inc.
   d. Senior Flexonics, Inc.; Pathway Division.

B. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.

1. Metal-Bellows Expansion Joints for Copper Piping: Multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
2. Metal-Bellows Expansion Joints for Steel Piping: Multiple-ply stainless-steel bellows, steel pipe end connections, and carbon-steel shroud.
3. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
4. Configuration: Double-bellows type with base, unless otherwise indicated.
5. End Connections: Flanged or welded.

C. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, anti-torque device, and removable end clip for positioning.

1. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
2. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.
3. Configuration for Steel Piping: Two-ply stainless-steel bellows and carbon-steel shroud.
4. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
5. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint.
6. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
7. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged or threaded.

D. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

1. Arch Type: Multiple arches.
2. Spherical Type: Multiple spheres.

    a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig.
    b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F.
    c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F.

3. Material: BR.
4. End Connections: Full-faced, integral, steel flanges with steel retaining rings.

E. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

1. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder-joint end connections.

    a. NPS 2 and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
    b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

2. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.

a. NPS 2 and Smaller: Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
c. NPS 8 and Larger: Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

F. Packed Slip Expansion Joints: ASTM F 1007, carbon-steel, packing type designed for repacking under pressure and pressure rated for 250 psig at 400 deg F minimum. Include asbestos-free PTFE packing, compound limit stops, and drip connection if used for steam piping.

1. Configuration: Double-joint class with base, unless otherwise indicated.
2. End Connections: Flanged or weld ends to match piping system.

G. Flexible Ball Joints: Carbon-steel assembly with asbestos-free composition packing, designed for 360-degree rotation and angular deflection, and 250 psig at 400 deg F minimum pressure rating; complying with ASME Boiler and Pressure Vessel Code: Section II, "Materials," and with ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.

1. Angular Deflection for NPS 6 and Smaller: 30-degree minimum.
2. Angular Deflection for NPS 8 and Larger: 15-degree minimum.
3. End Connections for NPS 2 and Smaller: Threaded.
4. End Connections for NPS 2-1/2 and Larger: Flanged.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Stud: Threaded, zinc-coated carbon steel.
2. Expansion Plug: Zinc-coated steel.
3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, 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 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.

B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. 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.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION

SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gages.
3. Test plugs.
4. Thermowells.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated; include scale range, ratings, and calibrated performance curves, certified where indicated. Submit a meter and gauge schedule showing manufacturer’s figure number, scale range, location, and accessories for each meter.

B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

1.3 QUALITY ASSURANCE

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages, including the following:

1. ASME B40.3, "Bimetallic Actuated Thermometers."
2. ASME B40.5, "Snubbers."
3. ASME B40.100, "Pressure Gauges and Gauge Attachments."
4. ASTM E 1, "Liquid-in-Glass Thermometers."

B. Design Criteria: The Drawings indicate types, sizes, capacities, ranges, profiles, connections, and dimensional requirements of meters and gages and are based on the specific manufacturer types and models indicated. Meters and gages having equal performance characteristics by other manufacturers may be considered, provided that deviations do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of meters and gages is on the proposer.

1.4 DELIVERY, STORAGE AND HANDLING

A. Follow manufacturer’s instructions for job site storage and protection of materials during construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE PRODUCTS BY ONE OF THE MANUFACTURERS INDICATED UNDER ALL CATEGORIES.

A. Metal-Case, Liquid-in-Glass Thermometers:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Duct-Type, Liquid-in-Glass Thermometers:

1. Miljoco Corp.
2. Palmer - Wahl Instruments Inc.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.

C. Direct-Mounting, Vapor-Actuated Dial Thermometers:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

D. Remote-Mounting, Vapor-Actuated Dial Thermometers:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

E. Bimetallic-Actuated Dial Thermometers:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

F. Thermowells:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

G. Pressure Gages:

1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.

H. Test Plugs:

1. MG Piping Products Co.
2. Trerice, H. O. Co.
3. Watts Industries, Inc.; Water Products Div.

2.2 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. General: Provide liquid-in-glass thermometers complying with ASTM E1.

B. Case: Die-cast aluminum, 9 inches long.

C. Tube: Red reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 DUCT-TYPE, LIQUID-IN-GLASS THERMOMETERS

A. Case: Die-cast aluminum, 7 inches long.

B. Tube: Red reading, organic filled, with magnifying lens.

C. Tube Background: Satin-faced, non-reflective aluminum with permanently etched scale markings.

D. Window: Glass.

E. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

F. Stem: Metal, for installation in mounting bracket and of length to suit installation.

G. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.4 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Drawn steel or cast aluminum metal or plastic, 4-1/2-inch diameter.

B. Element: Bourdon tube or other type of pressure element.

C. Movement: Mechanical, connecting element and pointer.

D. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Metal.

H. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

I. Thermal System: Organic liquid-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.5 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter with holes for panel mounting.

B. Element: Bourdon tube or other type of pressure element.

C. Movement: Mechanical, connecting element and pointer.

D. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Metal.

H. Connector: Bottom union type.

I. Thermal System: Organic liquid-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

J. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.6 BIMETALLIC-ACTUATED DIAL THERMOMETERS

A. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

B. Case: Dry type, stainless steel with 5-inch diameter.

C. Element: Bimetal coil.

D. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.

E. Pointer: Red metal.

F. Window: Glass.

G. Ring: Stainless steel.

H. Connector: Adjustable angle type.

I. Stem: Metal, for thermowell installation and of length to suit installation.

J. Thermal System: Organic liquid-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.7 THERMOWELLS

A. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

B. Stem length: Extend 2 inches into the fluid or into the center of the pipe. Extension for insulated pipe shall be 2 inches nominal, but not less than the thickness of the insulation.

C. Provide threaded cap nut with chain permanently fastened to well and cap.

2.8 PRESSURE GAGES

A. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Dry type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Glass.
8. Ring: Metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

B. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.9 TEST PLUGS

A. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

B. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

C. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

D. Test Kit: Furnish one test kit containing one pressure gage and adaptor, two thermometers, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations and elsewhere as noted:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. Outside-air, return-air, and mixed-air ducts.
6. As indicated on Drawings.

B. Install direct-mounting, vapor-actuated dial thermometers in the following locations and elsewhere as noted:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. As indicated on Drawings.

C. Install bimetallic-actuated dial thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler and chiller.

3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each hydronic heat exchanger.
5. As indicated on Drawings.

D. Install dry-case-type, vapor-actuated dial thermometers at suction and discharge of each pump and as indicated on Drawings.

E. Provide the following temperature ranges for thermometers:

1. Heating Hot Water (Condensing boiler applications): 30 to 220 deg F, with 2-degree scale divisions (Minus 1 to plus 150 deg C, with 1-degree scale divisions).
2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions).
3. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions (Minus 40 to plus 43 deg C, with 1-degree scale divisions).
4. Domestic Cold Water: 30 to 240 deg F, with 2-degree scale divisions (Minus 1 to plus 115 deg C, with 1-degree scale divisions).
5. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions).

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install dry-case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.

C. Install dry-case-type pressure gages at suction and discharge of each pump.

D. Install gages as indicated on Drawings.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

D. Duct Thermometer Support Flanges: Install in wall of duct where duct thermometers are indicated. Attach to duct with screws.

E. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

F. Install remote-mounting pressure gages on panel.

G. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

H. Install needle-valve and syphon fitting in piping for each pressure gage for steam.

I. Install test plugs in tees in piping. Provide a test plug at every thermometer and pressure gage location, and where indicated on the Drawings.

J. Install permanent indicators on walls or brackets in accessible and readable positions.

K. Install connection fittings for attachment to portable indicators in accessible locations.

3.4 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

B. Apply conductive pate to the thermometer or temperature sensor prior to installing it in the thermowell.

3.5 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION

SECTION 23 05 23

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following general-duty valves for HVAC piping:

1. Copper-alloy ball valves.
2. Ferrous-alloy butterfly valves.
3. Bronze check valves.
4. Ferrous-alloy wafer check valves.
5. Bronze gate valves.
6. Cast-iron gate valves.
7. Bronze globe valves.
8. Cast-iron globe valves.
9. Cast-iron plug valves.
10. Chainwheel actuators.

1.2 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.

1.3 SUBMITTALS

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.

1.4 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.

1.5 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 gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide valves by one of the following:

B. Bronze 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.

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. Bronze gate valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.
3. NIBCO INC.

G. Cast-iron gate valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.
3. NIBCO INC.
4. Watts Industries, Inc.; Water Products Div.

H. Bronze globe valves:

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.
3. NIBCO INC.

I. Cast-iron globe valves.

1. Crane Co.; Crane Valve Group; Stockham Div.
2. Milwaukee Valve Company.
3. NIBCO INC.

J. Cast-iron plug valves.

1. General Signal; DeZurik Unit.
2. Grinnell Corporation.
3. Tyco International, Ltd.; Tyco Valves & Controls.

K. 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, except plug valves.
5. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

G. Valves in insulated piping shall have 2-inch stem extensions and the following features:

1. Gate valves shall be rising stem type.
2. 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.
3. 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.

J. Solder Joint: With sockets according to ASME B16.18.

1. 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. Soldering of valves is not accepted, unless by written approval. Provide threaded ends wherever possible.

K. Threads shall be in accordance with ASME B1.20.1.

L. 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.

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 BRONZE GATE VALVES

A. Gate Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi cold working pressure (CWP), or Class 150, 300-psi CWP; ASTM B 62 cast-bronze body and bonnet, solid-bronze wedge, copper-silicon alloy rising stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

2.8 CAST IRON GATE VALVES

A. Gate Valves, 3 Inches and Larger: MSS SP-70, Class 125, 200-psi CWP, ASTM A 126 cast- iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with 2-piece packing gland assembly, flanged end connections; and with cast-iron handwheel.

2.9 BRONZE GLOBE VALVES

A. Globe Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; ASTM B 62 cast-bronze body and screwed bonnet, rubber, bronze, or teflon disc, silicon bronze-alloy stem, teflon-impregnated packing with bronze nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

2.10 CAST-IRON GLOBE VALVES

A. Globe Valves, 3 Inches and Larger: MSS SP-85, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted bonnet with bronze fittings, renewable bronze seat and disc, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

2.11 CAST-IRON PLUG VALVES

A. Plug Valves: MSS SP-78, 175-psi CWP, ASTM A 126 cast-iron body and bonnet, cast-iron plug, Buna N, Viton, or teflon packing, flanged or grooved end connections:

1. Operator: Lever.
2. Operator: Worm and gear with handwheel, sizes 6 inches and larger.
3. Operator: Worm and gear with chain wheel, sizes 6 inches and larger, 96 inches or higher above floor.

2.12 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, or gate or plug valves.
2. Throttling Service: Ball, butterfly, or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves.

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.
6. Gate Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
7. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, OS&Y, bronze-mounted cast iron.
8. Globe Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
9. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

D. Domestic 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. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
7. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.

E. 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.
7. Gate Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
8. Gate Valves, NPS 2-1/2 and Larger: Type I, Class 125, OS&Y, bronze-mounted cast iron.
9. Globe Valves, NPS 2 and Smaller: Type 2, Class 125, bronze.
10. Globe Valves, NPS 2-1/2 and Larger: Type I, Class 125, bronze-mounted cast iron.
11.

F. 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 22 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:

3. Swing Check Valves: In horizontal position with hinge pin level.

3.4 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic HVAC Materials and Methods" 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 PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following hangers and supports for mechanical system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Rooftop Pipe Supports.
7. Pipe positioning systems.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Rooftop Pipe Supports. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." and ASME Boiler and Pressure Vessel Code: Section IX.

1.5 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

1.6 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. Steel Pipe Hangers and Supports:

    a. Anvil
    b. B-Line Systems, Inc.; a division of Cooper Industries.
    c. Carpenter & Paterson, Inc.

2. Powder-Actuated Fasteners:

    a. Hilti, Inc.
    b. ITW Ramset/Red Head.

3. Mechanical-Expansion Anchors:

    a. B-Line Systems, Inc.; a division of Cooper Industries.
    b. Hilti, Inc.
    c. ITW Ramset/Red Head.

4. Rooftop Pipe Supports:

    a. Pate
    b. RPS
    c. Thybar

5. Thermal-Hanger Shield Inserts:

    a. Carpenter & Paterson, Inc.
    b. PHS Industries, Inc.
    c. Pipe Shields, Inc.

6. Pipe Positioning Systems:

    a. C & S Mfg. Corp.
    b. HOLDRITE Corp.; Hubbard Enterprises.

c. Samco Stamping, Inc.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to PART 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Corrosion Protection: Hangers and components shall be galvanized or painted with carbo-zinc #11.

C. Threads: All threads shall be UNC unless otherwise specified.

D. Heat Transmission: Supports, guides and anchors shall limit the amount of heat transmitted to the structural steel. Temperature of supporting parts shall be based on a 100°F per inch temperature gradient from the outside pipe surface.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 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 zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 ROOFTOP PIPE SUPPORTS

A. Description: Provide factory-fabricated steel sheet structural mounting supports. Construction shall include a welded 18-gauge galvanized steel shell, base plate and removable counterflashing. Support shall include a factory-installed wood nailer and internal bulkhead reinforcement. End sections shall be fully mitered. Support shall be compatible with insulated roof decks and include a 3 inch cant and variable step to match deck insulation thickness. The pipe roller assembly shall have galvanized 18 inches long continuous threaded rods to permit 12 inch vertical adjustments and a galvanized removable pipe retainer bracket.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Description: 100 psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

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.

2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, 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 APPLICATIONS

A. Specific hanger and support requirements are specified 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. Hangers installed outdoors shall have two coats of rust inhibitor paint after installation and adjustment.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. 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 non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
3. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

4. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

G. 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 20.

H. 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.

I. 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. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
9. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
10. 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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. 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.

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

N. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel 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 building structure.

B. 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 above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
3. Trapeze bars shall be tightly secured to structural members at two points with bolts or other similar mechanical fasteners. Hangers from bar joist and fabricated truss members shall be located at the panel points of the structural members. C-clamp type hangers attached to one side of double-angle bottom members are not allowed. Point loads shall not exceed the lesser of:

a. Manufacturer's certified recommendation for the component parts.
b. The following maximum point loads, and maximum hanger spacings as herein specified, for structural elements in any direction; except as specifically approved by the Structural Engineer of Record:

Structural Element Type	Maximum Hanger Point Load (lb)
Metal deck without concrete topping	50

Composite metal deck slab with concrete topping	50
Steel Beams:	
All channels, W4 through W8	100
W10 through W14	200
W16 through W24	400
W27 through W36	750
Built-up structural steel trusses	250
Reinforced post-tensioned concrete elements	
Slabs up to 6 inches thick	150
Slabs over 6 inches thick	250
Joists 8 inches wide	250
Beam/girders 8 inches wide	500

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. Drive screws, pins, studs, etc., of the type which are secured in place by means of explosive force may be used as a means of securing any of the hangers subject to the following:

    a. The stud, pin or fastener shall be caused to have a velocity not in excess of 300 feet per second when measured 6-1/2 feet from the muzzle of the tool by accepted ballistic test methods.
    b. Only workmen qualified by instructions of the manufacturer's representative and/or licensed by the state and local authorities shall be assigned to use a powder actuated fastening tool.
    c. Where practical, tools of only one manufacturer shall be used on a project.
    d. Only cartridges and fasteners supplied by the manufacturer of the tool shall be used to operate that tool.
    e. Powder actuated fastening tools shall be handled with the same care as firearms.
    f. All safety devices incorporated in the tool by the manufacturer shall be used at all times.
    g. Acceptable types of powder actuated fastening tools are:

1) Piston Tool - Low Velocity Type - is a tool utilizing a piston, activated by the power of a blank cartridge furnished by the manufacturer for use with it, to drive a stud, pin or fastener into a work surface.
2) Powder Assisted Hammer Drive Tool - Low Velocity Type - is a tool utilizing a captive piston, activated by a blow from a 4 lb. hammer supplemented by the power of a blank cartridge furnished by the manufacturer for use with the tool, to drive a stud, pin or fastener into a work surface.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. 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.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. 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.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:

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 according to ASME B31.1 for power piping and 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 wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 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 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 contours of welded surfaces match adjacent contours.

3.5 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.

3.6 PAINTING

A. Touch Up: 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 minimum dry film thickness of 2.0 mils.
2. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish. Hangers installed outdoors shall have two coats of rust inhibitor paint after installation and adjustment.
3. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 Section "Painting."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 23 05 48

VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

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 diffusers 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"(6mm) 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.

2.5 HANGERS

A. General: Hangers shall consist of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top, a steel spring with general characteristics as described in Paragraph 2.4, and shall be seated in a steel washer-reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated. The neoprene element shall not be stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc.

B. 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.

C. Hangers shall be manufactured with minimum characteristics as described in Paragraph 2.4, but without the neoprene element. Springs shall be seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod hanger contact. Spring diameters and the lower hole sizes shall be large enough to allow the hanger rod to

swing through a 30° arc from side to side before contacting the cup bushing. For ducts suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps. Submittals shall include a scale drawing of the hanger showing the 30° capability. Hangers for rods shall be Type 30 or for straps W30 as manufactured by Mason Industries, Inc.

2.6 HORIZONTAL THRUST RESTRAINTS

A. When total air thrust exceeds 10% of the isolated weight, floor mounted or suspended air handling equipment shall be protected against excessive displacement by the use of horizontal thrust restraints. The restraint shall consist of a modified spring mounting. Restraint springs shall have the same deflection as the isolator springs. The assembly shall be preset at the factory and adjusted in the field to allow for a maximum of 1/4" movement from stop to maximum thrust. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or structure. Attach restraints at the centerline of thrust and symmetrically on both sides of the unit. Horizontal thrust restraints shall be WB as manufactured by Mason Industries, Inc.

2.7 STEEL BASES

A. General: Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are standard for all equipment. Centrifugal refrigeration machines and pump bases may require T or L shapes. Pump bases for split case pumps shall be of the dimensions to support suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth shall not exceed 14" if the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Provide height saving brackets in all mounting locations for a base clearance of 1". Bases shall be type WF as manufactured by Mason Industries, Inc.

B. Partial Bases: Vibration isolation manufacturer shall provide steel members welded to height saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base. Members shall have sufficient rigidity to prevent distortion of equipment. Inverted saddles shall be type ICS, as manufactured by Mason Industries, Inc.

C. 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.

2.8 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.

2.9 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 2" of insulation. Curb shall be type RSC as manufactured by Mason Industries, Inc.

2.10 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"(350mm) 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.

2.11 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.

2.12 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.

2.13 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.

2.14 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.

2.15 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.

2.16 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.

2.17 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*
Refrigeration Machines				
Absorption Machine	Concrete Base	-	2.4B, 2.10	0.75
Centrifugal Machines				
Top Mounted Compressor	2.3, 2.10	0.35	2.4B, 2.10	1.5
Side Mounted Compressor	2.3, 2.10	0.35	2.4B, 2.10	1.5
Open Drive Compressor	2.3, 2.7, 2.10A	0.35	2.4B, 2.7, 2.10	1.5
Recip. Chiller	2.4B, 2.10A	0.75	2.4B, 2.10	1.5
Recip. Refrig. Comp.	2.4A, 2.7C, 2.11	0.75	2.4A, 2.7C, 2.11	1.5
Cabinet Fan Section High Pressure (5" & Above)	2.4A, 2.7C, 2.6	1.0	2.4A, 2.7C, 2.6	2.0
Low Pressure (Less than 5")	2.4A, 2.6	1.0	2.4A, 2.6	1.0
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	-	-	2.9	1.0
Suspended Air Handlers				
Up to 5 HP	-	-	2.5A	1.0
7-1/2HP and & Up	-	-	2.5A	1.5
Floor Mounted Air Handlers				
Up to 5 HP	2.3	0.35	2.4A	0.75
7-1/2 HP & Up	2.4A	0.75	2.4A	1.5

Dry Vacuum Pumps & Air Compressors				
Tank Type Horiz, Ver, 1 or 2 Cylinder	2.4A, 2.7C, 2.11	0.75	2.4A, 2.7C, 2.11	1.5

	Basement Slab Or Slab On Grade		Upper Floors	
Up to 499 RPM	2.4A, 2.7C, 2.11	2.5	2.4A, 2.7C, 2.11	2.5
500 RPM & Up	2.4A, 2.7C, 2.11	1.5	2.4A, 2.7C, 2.11	2.5
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
Tubular Centrifugal & Axial Fans				
Suspended	2.5A, 2.6	1.0	2.5A, 2.6	1.0
Floor Mtd - Motor on/in	2.3, 2.6	0.35	2.4A, 2.6	1.0
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
Cooling Towers & 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 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. Sample Schedules.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label. An electronic copy and hard copy will be provided to THE OWNER before preliminary acceptance. Furnish extra copies (in addition to mounted copies) for Maintenance.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals. An electronic copy and hard copy will be provided to the Owner before preliminary acceptance. Furnish extra copies (in addition to mounted copies) for Maintenance.

1.3 QUALITY ASSURANCE

A. Follow manufacturer’s recommended installation procedures.

B. As applicable, comply with ASME A13.1 “Scheme for the Identification of Piping System”

1.4 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.

1.5 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.

1.6 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. Seton
2. Brady
3. Best
4. Milwaukee

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch or Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Letter Size: 4 by 2 inch. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Fasteners: Stainless-steel self-tapping screws.
4. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation 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. See Sample Equipment Schedule at end of this Specification.

2.3 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 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. Coordinate with Architect and Owner for specific warning label information to be included.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. Do not provide labels for bare pipes conveying fluids at temperatures of 125 °F or higher.

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 1-1/2 inches high.

2.5 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: Black

C. Background Color: White.

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.

2.6 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 or Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped 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. See Sample Valve Tag Schedule at the end of this Specification.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 4 by 7 inches.
2. Fasteners: Reinforced 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. Piping Color-Coding: Painting of piping is specified in Division 09 Section " Painting**"**

B. 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.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping:

   a. Background Color: Blue.
   b. Letter Color: Black.

2. Condenser-Water Piping:

   a. Background Color: Blue.
   b. Letter Color: Black.

3. Heating Water Piping:

   a. Background Color: Red.
   b. Letter Color: Black.

4. Refrigerant Piping:

   a. Background Color: White.
   b. Letter Color: Black.

5. Low-Pressure Steam Piping:

   a. Background Color: White.
   b. Letter Color: Black.

6. Steam Condensate Piping:

    a. Background Color: White.
    b. Letter Color: Black

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts..

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. 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. Chilled Water: 2 inches, round.
    b. Condenser Water: 2 inches, round..
    c. Refrigerant: 2 inches, round..
    d. Hot Water: 2 inches, round.
    e. Gas: 2 inches, round..

2. Valve-Tag Color:

    a. Chilled Water: Natural.
    b. Condenser Water: Natural.
    c. Refrigerant: Natural.
    d. Hot Water: Natural.
    e. Gas: Natural.

3. Letter Color:

    a. Chilled Water: Black.
    b. Condenser Water: Black.
    c. Refrigerant: Black.
    d. Hot Water: Black.
    e. Gas: Black.
    f. .

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 SAMPLE SCHEDULES

A. The following tables are examples of schedules required to be submitted by the Contractor. Examples of the kinds of information to be included are in the first row in these tables.

CHILLED-WATER, VALVE-TAG SCHEDULE

VALVE NUMBER	VALVE TYPE	VALVE SIZE	VALVE LOCATION	NORMAL OPERATING POSITION	REMARKS
CHWS-1	GATE	NPS 2	MECHANICAL ROOM M-1	OPEN	

EQUIPMENT LABEL SCHEDULE

EQUIPMENT IDENTIFICATION	EQUIPMENT LOCATION	SPECIFICATION SECTION		REMARKS
		NUMBER	TITLE	
AHU-1	MECHANICAL ROOM M-215	23 xx xx		MODULAR INDOOR AIR-HANDLING UNITS

3.8 CLEANING

A. Follow manufacturer’s instructions for surface preparation prior to application or installation.

B. Follow Manufacturer’s instructions for cleaning labels and tags.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes procedural requirements for testing, adjusting, and balancing (TAB) of new and existing systems to achieve the required flows within the limits of the fan and the motor HP. The testing, adjusting, and balancing work includes producing design objectives for the following:

1. Air Systems:

   a. Constant-volume air systems.
   b. Variable-air-volume systems.
   c. Existing Systems.

2. Hydronic Piping Systems:

   a. Constant-flow systems.
   b. Variable-flow systems.
   c. Primary-secondary systems.
   d. Motors.
   e. Chillers.
   f. Condensing Units.
   g. Heat Transfer Coils.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, Adjusting, and Balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Firm: Entity responsible for performing and reporting TAB procedures.

F. TAB Specialist: Entity engaged by TAB Firm to perform TAB work.

1.3 SUBMITTALS

A. Qualification Data: Within **[30][45]** days of Notice to Proceed, submit documentation for the TAB contractor and the Project's TAB team members.

B. Contract Documents Examination Report: Within **[30][45]** days of Notice to Proceed, submit the Contract Documents Examination Report.

C. TAB Plan: Within **[30][60]** days of Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports. Submit two copies of the TAB reports prepared as specified in this specification on approved forms certified by the TAB contractor.

E. Sample report forms. Submit two copies of the sample TAB report forms

F. Instrument calibration reports, including the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.

B. Certification of TAB Reports: Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB forms from NEBB, AABC or TABB as well as providing any additional information required by this specification.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. Owner reserves the right to select at random 10% of the TAB report data for field verification witnessed by the commission agent. The TAB contractor will be given sufficient notice of the date of field verification. The same instruments that were used when the original test was recorded shall be used. A failure of more than 10% of the selected field verification items shall result in a repeat of the testing of the entire system at the TAB contractor's expense. The repeated work is also subject to field verification.

1.5 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.

1.6 WARRANTY

A. Provide warranty in accordance with AABC, NEBB or TABB standards:

1. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents.
2. 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.
3. Guarantee shall include the following provisions:

a. The certified TAB firm has tested and balanced systems according to the Contract Documents.
b. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents and field conditions to become familiar with Project requirements and to discover conditions that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

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 ceiling plenums used for return air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts," and are properly separated from adjacent areas. Verify that penetrations in plenum walls are properly sealed or, as required, fire-stopped.

F. Examine equipment performance data including fan and pump curves.

1. 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.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that screens are clean and proper perforations are provided. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine equipment for installation and properly operating safety interlocks and controls.

P. 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.

3.2 PREPARATION

A. Prepare a TAB Plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare 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.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance," ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," and this Section.

1. Comply with requirements in ASHRAE 62.1-2007, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

E. HVAC system lineup. The contractor will test the system in the normal system lineups.

1. A hydronic system with two chillers designed to run at the same time, the system will be balanced with pumps flowing to both chillers. All pump data will also be collected when the pump is flowing to only one chiller.
2. Air systems will be balanced while aligned for minimum outside air flow and the position of the outside air dampers will be recorded for the minimum position.
3. It s not acceptable to balance air systems when the normal boundaries, doors, walls, or ductwork are not in their design configuration.

3.4 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 outdoor-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.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer and within the limits of the motor HP. All fans shall deliver the design air flow capacity at actual static pressure up to design static. Fan sheaves shall be replaced as necessary to obtain desired results.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube-traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical 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 the 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.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
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 mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, sub-main ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of sub-main and branch ducts.

a. Where sufficient space in sub-main 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. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.

C. Measure air 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 air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch 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.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. 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 minimum set-point airflow with the remainder at maximum-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.

1. Minimum outside air flow rate must be verified under three conditions, with the OA damper position recorded in each configuration.

a. System operating with all boxes at minimum primary air flow.
b. System at maximum supply flow (diversity may not allow all boxes to be open).
c. System flow halfway between box minimum and maximum.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set 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 the 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 the same 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 the same 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. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same 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 final fan-performance data.

C.

3.7 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 the 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 liquid level in expansion tank.
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.

3.8 PROCEDURES FOR CONSTANT-FLOW 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.

    a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from the Board Authorized Representative and comply with requirements in Division 23 Section "Hydronic Pumps."

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.

    a. Monitor motor performance during procedures and do not operate motors in overload conditions.

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 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presets.

E. 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.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. 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.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 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.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

B.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
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 of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.12 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water 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. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant 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.

3.14 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.

6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer and within the limits of the motor HP. All fans shall deliver the design air flow capacity at actual static pressure up to design static. Fan sheaves shall be replaced as necessary to obtain desire results.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. Balance each air outlet.

3.15 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.

3.16 TOLERANCES

A. Set HVAC system air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 5 percent.

3.17 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.

3.18 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. 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; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
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 supervisor 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's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

a. Settings for outdoor-, 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.

D. 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 outdoor, supply, return, and exhaust airflows.
2. Water and steam 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.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

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. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow 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.
f. Preheat coil static-pressure differential in inches wg.
g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. 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.
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. Air flow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-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.

G. Gas- and Oil-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 Btu/h.
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. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total air flow 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 Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in kW
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Air flow 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 kW
b. Air flow 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. 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

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.

J. 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 air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.

k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm
b. Air velocity in fpm
c. Preliminary air flow rate as needed in cfm
d. Preliminary velocity as needed in fpm
e. Final air flow rate in cfm
f. Final velocity in fpm
g. Space temperature in deg F

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature 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 number and serial number.
f. Fluid flow rate in gpm
g. Fluid 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): All values measured in a fluid other than water will include the measured value corrected to the equivalent in water.

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 fluid flow rate in gpm.
j. Voltage, phase to phase.
k. Amperage for each phase.

3. Air-Cooled Condenser Test Data (Indicated and Actual Values):

a. Refrigerant pressure in psig.
b. Refrigerant temperature in deg F.
c. Entering- and leaving-air temperature in deg F.

4. 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.

5. 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. Condenser-water control set point in deg F.
m. Refrigerant low-pressure-cutoff set point in psig.
n. Refrigerant high-pressure-cutoff set point in psig.

6. 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.

N. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Unit make and model number.
d. Compressor make.
e. Compressor model and serial numbers.
f. Refrigerant weight in lb.
g. Low ambient temperature cutoff in deg F.

2. Test Data (Indicated and Actual Values):

a. Inlet-duct static pressure in inches wg.
b. Outlet-duct static pressure in inches wg.
c. Entering-air, dry-bulb temperature in deg F.
d. Leaving-air, dry-bulb temperature in deg F.
e. Condenser entering-water temperature in deg F.
f. Condenser leaving-water temperature in deg F.
g. Condenser-water temperature differential in deg F.
h. Condenser entering-water pressure in feet of head or psig.
i. Condenser leaving-water pressure in feet of head or psig.
j. Condenser-water pressure differential in feet of head or psig.
k. Control settings.
l. Unloader set points.

m. Low-pressure-cutout set point in psig.
n. High-pressure-cutout set point in psig.
o. Suction pressure in psig.
p. Suction temperature in deg F.
q. Condenser refrigerant pressure in psig.
r. Condenser refrigerant temperature in deg F.
s. Oil pressure in psig.
t. Oil temperature in deg F.
u. Voltage at each connection.
v. Amperage for each phase.
w. Kilowatt input.
x. Crankcase heater kilowatt.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm.
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

O. Condenser Test Reports: For condensers, include the following:

1. Unit Data:

a. Unit identification.
b. Make and type.
c. Model and serial numbers.
d. Nominal cooling capacity in tons.
e. Refrigerant type and weight in lb.
f. Water-treatment chemical feeder and chemical.
g. Number and type of fans.
h. Fan motor make, frame size, rpm, and horsepower.
i. Fan motor voltage at each connection.
j. Sheave make, size in inches, and bore.
k. Sheave dimensions, center-to-center, and amount of adjustments in inches.
l. Number of belts, make, and size.
m. Pump make and model number.
n. Pump manufacturer's serial number.
o. Pump motor make and frame size.
p. Pump motor horsepower and rpm.

P. Boiler Test Reports:

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.

Q. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.19 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.
b. Measure water flow of at least 5 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner's Representative.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the Board Authorized Representative.
3. The Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.20 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB 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 TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Calcium silicate.
b. Flexible elastomeric.
c. Mineral fiber.
d. Polyisocyanurate.

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. Identification
11. Tapes.
12. Securements.
13. Corner angles.

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 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.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thermal resistivity (R-value), thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

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, flanges, valves, and specialties 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 of Identification
8. Detail application at linkages of control devices.
9. Detail field application for each equipment type.
10. Detail outdoor duct insulation installation.

C. Samples: For each type of insulation jacket, and identification indicated. Identify each Sample, describing product and intended use.

1. Sample Sizes:

a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
b. Sheet Form Insulation Materials: 12 inches square.
c. Jacket Materials for Pipe: 12 inches long by NPS 2.
d. Sheet Jacket Materials: 12 inches square.
e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Material Test Reports: From a qualified testing agency acceptable to the 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.

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: Except where indicated otherwise, insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by UL or another testing and inspecting agency acceptable to the authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors:

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 50 or less.

2. Insulation Installed Outdoors:

a. Flame-Spread Index: 75 or less.
b. Smoke-Developed Index: 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages and containers with seals unbroken and bearing manufacturer's original labels, including manufacturer's name, product name, and directions for storing, handling, and use.

B. Store materials in a clean, dry, fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

1. Remove damaged or wet insulation from Project site.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for 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.

1.7 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.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.8 WARRANTY

A. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of Preliminary Acceptance or Substantial Completion, whichever is longer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers and Products: Subject to compliance with requirements, provide one of the following products for each of the products identified:

1. Flexible Elastomeric Insulation:

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. Calcium Silicate Insulation:

a. Industrial Insulation Group (The): Thermo-12 Gold.
b. Johns-Manville.
c. Owens-Corning Corporation.
d. PABCO.
e. Schuller International Inc.

5. Fire-Rated Blanket Insulation:

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.

6. 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.

7. 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.

8. Polyisocyanurate Insulation:

    a. Apache Products Company; ISO-25.
    b. Dow Chemical Company (The); Trymer.
    c. Duna USA Inc.; Corafoam.
    d. Elliott Company; Elfoam.

9. Mineral-Fiber Insulating Cement:

    a. Insulco, Division of MFS, Inc.; Triple I.
    b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

10. 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.

11. Polyisocyanurate,Adhesive:

    a. Childers Products, Division of ITW; CP-96.
    b. Foster Products Corporation, H. B. Fuller Company; 81-33.

12. 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.

13. 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.

14. 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.

15. 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.

16. 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.

17. Lagging Adhesives:

a. Childers Products, Division of ITW; CP-52.
b. Foster Products Corporation, H. B. Fuller Company; 81-42.
c. Vimasco Corporation; 136.

18. 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.

19. 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.

20. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

a. Childers Products, Division of ITW; CP-76.

21. PVC Jacket:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

22. Metal Jacket:

a. Childers Products, Division of ITW; Metal Jacketing Systems.
b. IDC Corporation.
c. RPR Products, Inc.; Insul-Mate.

23. Identification:

a. Seton.
b. Brady.
c. Best.
d. Milwaukee.

24. 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.

25. 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.

26. 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.

27. Bands:

    a. Childers Products; Bands.
    b. IDC Corporation.
    c. RPR Products, Inc.; Bands.

28. 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

29. 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: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and 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 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. Calcium Silicate Insulation:

1. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
4. Thermal Conductivity: 0.50 at 200 deg F.
5. Dry Density: 22.0 pcf maximum.
6. Compressive Strength: 60 psi minimum at 5 percent deformation.
7. Fire-Test-Response Characteristics: Provide insulation and related materials with a flame spread index of 0 and smoke developed index of 0, as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to the authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

J. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested by UL, or another testing and inspecting agency acceptable to the authorities having jurisdiction, and certified to provide a 2-hour fire rating.

K. Mineral-Fiber, Preformed Pipe Insulation:

L. 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. 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 For less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

M. 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 UL or another testing and inspecting agency acceptable to the authorities having jurisdiction.

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. Adhesives, General: All adhesives and mastics installed within the building envelope shall be shown to comply either 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," including 2004 Addenda, or with the VOC limits established in South Coast Air Quality Management District (SCAQMD) Rule #1168.

1. Aerosol adhesives shall comply with Green Seal Standard for Commercial Adhesives GS-36 (2000).

B. Compatibility: 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. Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

D. Flexible Elastomeric 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 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.

H. Mastics: Comply with MIL-C-19565C, Type II. Materials shall be compatible with insulation materials, jackets, and substrates.

1. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

a. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 permat 43-mildry film thickness.
b. Service Temperature Range: Minus 20 to plus 180 deg F

c. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
d. Color: White.

2.6 Lagging Adhesives: Comply with MIL-A-3316C Class I, Grade A. Materials shall be compatible with insulation materials, jackets, and substrates.

a. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
b. Service Temperature Range: Minus 50 to plus 180 deg F.
c. Color: White.

2.7 SEALANTS

A. Sealants, General: All sealants installed within the building envelope shall be shown to comply either 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," including 2004 Addenda, or with the VOC limits established in South Coast Air Quality Management District (SCAQMD) Rule #1168.

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. 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 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.

2.8 JACKETS

A. Factory-Applied Jackets: 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.

B. Field-Applied Jackets: Comply with ASTM C 921, Type I, unless otherwise indicated. Field-applied jackets shall be provided on all piping below 8 ft. height.

1. PVC Jackets: 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.

a. Adhesive: As recommended by jacket material manufacturer.
b. Color: White.
c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

1) 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.

d. Factory-fabricated tank heads and tank side panels.

2. Metal Jackets:

a. Stainless-Steel Jackets: ASTM A 167 or ASTM A 240.

1) Sheet and roll stock ready for shop or field sizing.
2) Material, finish, and thickness are indicated in field-applied jacket schedules.
3) Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
4) Moisture Barrier for Outdoor Applications: 2.5-mil-thick Polysurlyn.
5) Factory-Fabricated Fitting Covers: Fabricated from the same material, finish, and thickness as jacket. Provide factory-fabricated covers for preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows; tee covers; flange and union covers; end caps; beveled collars; and valve covers. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

b. Aluminum Jackets: Comply with ASTM B 209, Alloy 3003, Temper H-14.

1) Sheet and roll stock ready for shop or field sizing.
2) Finish and thickness are indicated in field-applied jacket schedule.
3) Moisture Barrier for Indoor Applications: 3-mil thick Polysurlyn.
4) Moisture Barrier for Outdoor Applications: 3-mil thick Polysurlyn.
5) Factory-Fabricated Fitting Covers: Fabricated from the same material, finish, and thickness as jacket. Provide factory-fabricated covers for preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows; tee covers; flange and union covers; end caps; beveled collars; and valve covers. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 IDENTIFICATION

A. General: Products specified are manufacturer's standard products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for listed application, selection is Installer's option but provide single selection for each product category.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Seton.
2. Brady.
3. Best.
4. Milwaukee.

C. Snap-On Plastic Pipe Markers: Manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers.

1. Lettering: Use piping system terms as indicated and abbreviate only as necessary for each application length.
2. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.

D. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

1. Multiple Systems: Where multiple systems of same name are indicated, identify individual system number as well as service.

E. Color Coding:

		Background	Lettering
1.	Domestic Cold Water	White	Black
2.	Domestic Hot Water/ Hot Water Return	Blue	White
3.	Non Potable Water/ Makeup Water	Purple	White
4.	Condenser Water	Black	White
5.	Storm Water	Grey	White
6.	Rain Water Harvesting	Grey	White
7.	Air Conditioning Condensate	Grey	White
8.	Chilled Water	Green	White
9.	Dual Temp. Water	Brown	White
10.	Heating Hot Water	Orange	White
11.	Steam/ Steam Condensate	Yellow	Black
12.	Refrigerant Suction/ Hot Gas	Clear	Black
13.	Natural Gas	Yellow	Black
14.	Fire Protection	Red	White

2.10 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.

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.020-inchthick, 3/4-inchwide with wing 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- 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:

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:

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.

2.12 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, Type 304 or Type 316.

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.

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.

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 INSTALLATION – GENERAL

A. Install insulation materials, accessories, and finishes according to the manufacturer's written instructions 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. Keep insulation materials dry during application and finishing.

E. Install insulation with least number of joints practical.

F. Install insulation with longitudinal seams at top and bottom of horizontal runs.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install multiple layers of insulation with longitudinal and end seams staggered.

I. Install vapor barriers on insulated pipes, ductwork, and equipment having surface operating temperatures below 60 deg F.

J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

K. 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.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. 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. Install insulation with longitudinal seams at bottom of pipe. 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.
    b. Exception: Do not staple longitudinal laps on insulation applied to piping systems with a surface temperature at or below 35 deg F.

4. Cover joints and seams with tape as recommended by insulation material manufacturer 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.
6. At penetrations in jackets for thermometers, and pressure gages, fill and seal voids with vapor barrier coating.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. 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.

Q. 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 walls and partitions in accordance with requirements of approved and tested assembly indicated. 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 Division 07 Section "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.

a. 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.
b. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

2. Pipe: Install insulation continuously through floor penetrations.

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, where insulation support rings are not provided, or where insulation is to be secured with tie wire or bands, install a girdle network for securing insulation.

a. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs.
b. Place one circumferential girdle around equipment approximately 6 inches from each end.
c. Install wire or cable between two circumferential girdles 12 inches o.c.
d. 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.
e. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c.

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-inchcenters, 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 PIPE INSULATION INSTALLATION – GENERAL

A. General: Requirements in this article apply to all insulation materials, unless more specific requirements are indicated for individual pipe insulation types.

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. Pipe Elbows: 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. Tee Fittings: 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. Valves: 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. Strainers: 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. Fittings and Unions: 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, 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. 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 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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 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 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 1 edge and 1 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 Fat 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 2 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 1 edge and 1 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 Fat 18-footintervals. 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 2 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 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings and Ductwork:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch, soft-annealed, stainless-steel wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Apply a thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Apply a thin finish coat to achieve smooth, uniform finish.

C. 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 cut sections of block insulation of same material and thickness as pipe insulation.

4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with stainless-steel wire.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

F. Metal Jacket: Where indicated, apply metal jacket over finished insulation as specified in this Section for installation of metal jackets.

3.10 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 o'clock 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.

3.11 WEATHERPROOF DUCT INSULATION INSTALLATION

A. Provide thickness of polyisocyanurate insulation as indicated in the Schedule at the end of PART 3. Provide on the exterior of all supply, and return, ducts exposed to the weather.

B. Cover insulation with a field-applied jacket.

C. Top of duct insulation shall overlap the side of duct insulation. Side of duct insulation shall overlap the bottom of duct insulation. Provide corner angles at each corner.

D. Top of duct insulation shall be pitched for drainage. Pitch shall be a minimum of 1/2 inch per foot from the high point at the duct horizontal longitudinal centerline to the low points at the outsides of the duct. Insulation thickness at the low points shall be the minimum indicated in the Schedule at the end of PART 3. Duct pitch shall be achieved by either of the following:

1. Tapered insulation.
2. Insulation with tapered fesco board to achieve the pitch.
3. For ducts over 6 ft. wide, tapered continuous wood shims (1 in. wide) running laterally from the duct centerline high point to the low points at the outsides. Shims shall be located at 12 inches o.c. along the length of the duct.

E. Vapor retarder type mastic, or joint sealer, shall be applied on longitudinal and butt joints to prevent moisture and moisture vapor infiltration. Vapor retarder butt joints shall be sealed with 3 in. wide vapor retarder tape.

F. Apply insulation in a solid bed of waterproof adhesive.

G. Tightly wrap the insulation circumferentially with saran film. Overlap the seams by a minimum of 2 inches. Seal the overlapped seams with vapor retarder tape.

H. Secure the insulation with stainless steel bands on 12-inch centers.

I. Jacketing shall be secured with 1/2-inch wide stainless steel bands on 12 inch centers. Rivets, screws, staples, or any other fastener capable of penetrating the underlying vapor retarder shall not be used.

3.12 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.

B. Where Stainless Steel, or Aluminum, 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.

3.13 LABELING AND IDENTIFYING INSTALLATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Plastic markers with application systems. Install on pipe insulation segment where required for hot non-insulated pipes.

a. Fasten markers on pipes smaller than 6-inch diameter by one of following methods:

1) Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2) Adhesive lap joint in pipe marker overlap.
3) Laminated or bonded application of pipe marker to pipe (or insulation).
4) Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4-inch wide, lapped 1-1/2 inches minimum at both ends of pipe marker, and covering full circumference of pipe.

b. Fasten markers on pipes 6-inch and larger diameter by one of following methods:

1) Laminated or bonded application of pipe marker to pipe (or insulation).
2) Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2-inches wide, lapped 3 inches minimum at both ends of pipe marker, and covering full circumference of pipe.
3) Strapped to pipe (or insulation) with manufacturer's standard stainless steel bands.

2. Locate pipe markers and color bands as follows wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

a. Near each valve and control device.
b. Near each branch connection, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
c. Near penetrations through walls, floors, ceilings, or enter non-accessible enclosures.
d. At access doors, manholes, and similar access points that permit view of concealed piping.
e. Near major equipment items and other points of origination and termination.
f. Spaced at a maximum of 50-feet o.c. along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.
g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.14 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 in accordance with Division 07 Section "Penetration Firestopping."

3.15 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 for each duct system defined in the Article "Duct Insulation Schedule, General".
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 Article "Piping Insulation Schedule, General".

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Architect may reject all work if sample work is found to be defective.

3.16 DUCT INSULATION PERFORMANCE , GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, supply and outdoor air.
2. Indoor, concealed return located in non-conditioned space.
3. Indoor, return located in non-conditioned space.
4. Indoor, kitchen hood exhaust.
5. Indoor, exhaust between isolation damper and penetration of building exterior.
6. Outdoor, supply, return and outdoor air.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.

3.17 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. Indoor, Concealed duct insulation shall be mineral fiber blanket unless indicated otherwise.

C. DUCT SYSTEMS INSULATION SCHEDULE

DUCT LOCATION	**OUTSIDE AIR, SUPPLY AIR, EXHAUST AIR (DOWNSTREAM OF DAMPER) INSULATION INSTALLED R-VALUE ($H \cdot Ft^2 \cdot deg\ F/BTU$)**	**RETURN AIR INSULATION INSTALLED R-VALUE ($H \cdot Ft^2 \cdot deg\ F/BTU$)**
Exterior of Building (Notes 5, 6, 8)	8.0	8.0
Ventilated Attic (Notes 5, 7)	8.0	8.0
Unvented Attic Above Insulated Ceiling (Notes 5, 7)	8.0	8.0
Unvented Attic with Roof Insulation (Notes 1, 5, 7)	6.0	N/A
Unconditioned Space (Notes 2, 5, 6, 7)	8.0	8.0
Indirectly Conditioned Space (Notes 3, 7)	6.0	N/A
Ceiling Cavity / Shafts / Soffits / Mechanical Spaces and Rooms (Notes 4, 5, 6, 7)	6.0	N/A
Exposed Locations within Conditioned Space	6.0	N/A
Buried	6.0	N/A

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. WHERE EXTERIOR WALLS ARE USED AS PLENUM WALLS, WALL INSULATION SHALL BE AS REQUIRED BY THE MOST RESTRICTIVE CONDITION OF ASHRAE 90.1-2004 SECTION 5 OR 6.4.4.2. INSULATION RESISTANCE MEASURED ON A HORIZONTAL

PLANE IN ACCORDANCE WITH ASTM C518 AT A MEAN TEMPERATURE OF 75F AT THE INSTALLED THICKNESS.

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 (STAINLESS STEEL, OR ALUMINUM, FOR EXTERIOR APPLICATIONS, PVC FOR INTERIOR EXPOSED LOCATIONS).

NOTE 7: PROVIDE MINERAL FIBER BOARD WITH FIELD APPLIED JACKET (SS, OR A, EXTERIOR, ALL SERVICE INTERIOR) IN EXPOSED LOCATIONS IN LIEU OF MINERAL FIBER BLANKET.

NOTE 8: PROVIDE POLYISOCYANURATE BOARD INSULATION FOR OUTDOOR DUCTWORK

D. KITCHEN EXHAUST DUCTS

MATERIAL	FORM	THICKNESS (INCHES)	VAPOR BARRIER REQUIRED	FIELD-APPLIED JACKET
Fire-Rated Blanket	Blanket	Note 1	No	None
Calcium Silicate	Board	Note 1	No	(SS) Exposed Duct

NOTE 1: AS REQUIRED TO PROVIDE A 2-HOUR FIRE RATING.

E. CONVECTION OVEN AND DISHWASHER EXHAUST DUCTS

MATERIAL	FORM	THICKNESS (INCHES)	VAPOR BARRIER REQUIRED	FIELD-APPLIED JACKET
Glass Fiber	Board	2	No	(SS) Exposed Duct
Calcium Silicate	Board	2	No	(SS)
Fire-Rated Blanket	Blanket	Note 1	No	None

NOTE1: AS REQUIRED FOR A 2 HR RATING.

F. COMBUSTION AIR DUCTS

MATERIAL	FORM	THICKNESS (INCHES)	VAPOR BARRIER REQUIRED	FIELD-APPLIED JACKET
Glass Fiber	Board	2	Yes	None

3.18 EQUIPMENT INSULATION SCHEDULE

A. General: 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. Chillers: See Chiller Specification Section for insulation of cold surfaces of Chillers.

D. Heat-exchanger (water-to-water for heating service) 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.

E. Steam-to-hot-water converter insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density. Stainless steel jacket.
2. Mineral-Fiber Pipe and Tank: 2 inches thick. Stainless steel jacket.

F. Chilled-water pump insulation shall be the following:

1. Mineral-Fiber Board**:** 2 inches thick and 3-lb/cu. ft. nominal density. Vapor barrier.

G. Dual-service heating and cooling pump insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick an 3-lb/cu. ft. nominal density. Vapor barrier.

H. 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.

I. Steam condensate pump and boiler feed-water pump 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.

J. Chilled-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.

K. Dual-service heating and cooling expansion/compression tank 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

L. Heating-hot-water expansion/compression tank insulation shall be one of the following:

1. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density. PVC jacket.
2. Mineral-Fiber Pipe and Tank: 1 inch thick. PVC jacket.

M. Chilled-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.

N. Dual-service heating and cooling 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.

O. Heating-hot-water air-separator 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.

P. De-aerator 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.

Q. Steam condensate tank and receiver 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.

R. Steam flash-tank, flash-separator, and blow-off-tank insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 2 inches thick.

S. 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.

3.19 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.

3.20 PIPING INSULATION SCHEDULE

A. Abbreviations used in the following schedule include:

1. Field-Applied Jackets: P - PVC, K - Foil and Paper, A - Aluminum, SS - Stainless Steel.
2. Pipe Sizes: NPS - Nominal Pipe Size.

B. Minimum HVAC Pipe Insulation Thickness Table (Non-LEED Projects):

HEATING SYSTEMS (Steam and Hot Water) (Note 1)	**FLUID TEMPERATURE RANGE (deg F)**	**INSULATION TYPE / FIELD-APPLIED JACKET / IDENTIFICATION**			**PIPE SIZE AND INSULATION THICKNESS (INCHES)** (Note 5, 6)				
		Glass Fiber	Polyiso-cyanurate	Flexible Elasto-meric	<1" (Note 4)	1" to <1-1/2"	1-1/2" to <4"	4" to 6"	8" and Larger
High Pressure/	306 – 450	X			2-1/2	3	3	4	4-1/2

Temperature									
Medium Pressure/ Temperature	251 – 305	X			2	2-1/2	3	3	3
Low Pressure/ Temperature	201 – 250	X			1-1/2	1-1/2	2	2	2
Low Temperature	106 – 200	X		X	1	1	1-1/2	1-1/2	1-1/2
Steam Condensate (for feed water)	Any	X		X	1	1-1/2	2	2	2
COOLING SYSTEMS									
Chilled Water, Refrigerant, and Brine	40 – 60	X (Note 2, 7)	X (Note 2, 3, 7)	X (Note 7)	1/2	3/4	1	1	1
	Below 40	X (Note 2, 7)	X (Note 2, 3, 7)	X (Note 7)	1	1-1/2	1-1/2	1-1/2	1-1/2
Indoor Air-Conditioning Condensate Drains	40 – 60	X		X	1	1	1	1	1

NOTE 1: GLASS-FIBER INSULATION ONLY FOR HYDRONIC PIPING.
NOTE 2: (P), (A), OR (SS) FIELD-APPLIED JACKET ON OUTDOOR INSTALLATIONS, EXPOSED AND CONCEALED.
NOTE 3: FOR OUTDOOR USE ONLY.
NOTE 4: PIPING INSULATION IS NOT REQUIRED BETWEEN THE CONTROL VALVE AND COIL ON RUNOUTS, WHEN THE CONTROL VALVE IS WITHIN 4-FEET OF THE COIL AND THE PIPE SIZE IS 1-INCH OR LESS.
NOTE 5: FOR PIPING EXPOSED TO OUTDOOR AIR, INCREASE INSULATION THICKNESS BY 1-INCH.
NOTE 6: INSULATION THICKNESS IS BASED ON INSULATION HAVING A THERMAL CONDUCTIVITY OF 0.22 – 0.25 BTU·INCH/(H·FT^2·deg F)
NOTE 7: VAPOR BARRIER REQUIRED.

3.21 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material for all piping below 8 ft. height. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Provide identification for all piping.

C. Piping, Exposed:

1. PVC, White – below 8 ft. height: 20 mils thick.

3.22 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: 0.020 inch thick.
2. Aluminum, Alloy 3003, Temper H-14, Smooth Finish: 0.020 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 Finish: 0.020 inch thick.
2. Aluminum, Alloy 3003, Temper H-14, Smooth Finish: 0.020 inch thick.

D. Piping, Exposed

1. Stainless Steel, Type 304 Smooth 2B Finish 0.016 inch thick.

3.23 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF HVAC

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 commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Provide documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel. Work with the Commissioning Authority and in cooperation with other members of the commissioning team to ensure compliance.

C. Refer to Section 01 9113 GENERAL COMMISSIONING REQUIREMENTS for commissioning requirements.

D. Related Sections:

1. Division 01 Section "General Commissioning Requirements" for commissioning process requirements.

2. Division 23 Sections related to Testing, Adjusting and Balancing (TAB)

1.3 COMMISSIONING

A. This section governs the commissioning of Heating Ventilating Air Conditioning and Refrigeration (HVAC &R) systems

B. The following systems and equipment shall be commissioned.
1. Building Automation System
2. Central Plant Heating and Cooling Equipment
3. Make-up Air Units
4. Air Handling Units
5. Terminal Units
6. Unit Heaters
7. Exhaust Fans
8. Electric Baseboards
9. Fan Coil Units
10. Piping
11. Pumps

C. Refer to Division 01. Section 01 91 13, "General Commissioning Requirements" for the Work related to commissioning of these systems.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION: NOT USED

END OF SECTION

SECTION 23 09 20

BUILDING AUTOMATION SYSTEM (BAS) - GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the installation of a building automation system (BAS) for control and monitoring of mechanical systems as indicated.

1.2 SYSTEM DESCRIPTION

A. The distributed digital control (DDC) and building automation system (BAS) defined herein shall provide a complete Building Automation System (BAS) for all mechanical systems and other facility systems as included in the project documents. The contractor shall provide a complete and operational system to perform all sequences of operations stated in the Article "Sequence of Operation" or as shown on the control drawings.

B. The BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform the control sequences and functions specified. The BAS for this project shall consist of monitoring and control of the systems indicated.

C. The BAS system shall include the following:

1. One (1) Webserver (control system server CSS)
2. One (1) Desktop operator workstation (OWS)
3. All the software tools required to configure and maintain the server, OWS, and any local devices.

D. All interlock wiring for mechanical system equipment shall be by this contractor unless specifically stated otherwise. This shall include, but not be limited to, items such as thermostats for unit heaters, interlock wiring to central boiler control panels, chiller flow switches, and duct smoke detectors.

1.3 APPLICATION OF OPEN SYSTEM (PROTOCOL AND LICENSING)

A. Subject to the detailed requirements provided throughout the specification and contract documents, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing one of the following standards:

1. BACnet: System components shall communicate using native BACnet in accordance with ASHRAE Standard 135 and current addenda and annexes, including:
    a. All workstations
    b. All BACnet Building Controllers (B-BC)
    c. All Advanced Application Controllers (B-AAC)
    d. All Application Specific Controllers (B-ASC).
    e. Gateways from other communication protocols are not acceptable.
    f. All controllers must be BACnet Testing Labs listed for their required profile (B-BC, B-AAC or B-ASC).

B. Software Licensing:

1. Include open/non-proprietary licensing for all software packages at all required Operator Interface as listed in Division 23 Section "Building Automation System – Operator Interfaces".
2. All operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be included, licensed, and provided to the Owner.
3. Open/non-proprietary licensing shall allow access to all aspects of the system including system access, thin-client workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing.
4. Hardware and software keys to provide all rights shall be fully provided and installed on all operator interface(s). At least 2 sets of CDs/USB drivers shall be provided with backup software for all software provided, so that the Owner may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses. These backup disks shall include a backup of all program data files, graphics etc. and shall allow the owner to completely restore the system in the case of a computer malfunction.

1.4 ACCEPTABLE MANUFACTURERS:

A. Qualifications: The following companies are pre-approved to install a web-based BAS system:

Manufacturer/Contractor

1. Johnson Facility Explorer Controls with Tridium-N4 by Branch Office
2. Johnson Facility Explorer Controls with Tridium-N4 by Building Asset Systems LLC
3. Johnson Facility Explorer Controls with Tridium-N4 by Interactive Building Solutions

4. Honeywell Spyder Controls with Tridium-N4 by Branch Office
5. Honeywell Spyder Controls with Tridium-N4 by Integrated Controls Technologies, LLC
6. Honeywell Spyder Controls with Tridium-N4 by BCE, Inc.
7. Honeywell Spyder Controls with Tridium-N4 by AMS Mechanical
8. Honeywell Spyder Controls with Tridium-N4 by Interactive Building Solutions

9. Vykon with Tridium-N4 by Integrated Control Technologies
10. Vykon with Tridium-N4 by Precision Control Systems

11. No substitution.

B. This listing is a pre-approval only and shall not relieve the Contractor of compliance with any Contract Document requirements.

C. Any and all work that may be required to accommodate any items or equipment of the other acceptable manufacturers listed in the Contract Documents is, without limitation, subject to the review of the EOR.

1.5 QUALITY ASSURANCE

A. Contractor Experience

1. The BAS as defined in the Contract Documents is considered to be a highly specialized system. The Contractor shall be a building automation system specialist regularly engaged in the engineering, programming, installation, and service of building automation systems of similar size and complexity. As a building automation system specialist, the Contractor is expected to demonstrate an understanding of the systems and equipment to be placed under control, including knowledge of acceptable engineering, programming, installation, and wiring interface methods. The Contractor shall submit in writing at the time of subcontractor approval the following information for review by the EOR:

    a. Documentation to have a substantial experience with the complete, turn-key installation of building automation systems of similar scope and size as this project. Document this business experience.

    b. Documentation to have a local service facility within a 50 mile radius of the job site.

    c. Documentation to have a service department staff, fully capable of providing instructions as well as routine and emergency maintenance service on all system components.

    d. Documentation to have emergency services, available on a 24 hour, 7 day a week basis. Describe this local service capability.

    e. The Contractor shall employ specialists in the field of building automation systems including: project management, engineering, programming, field supervision installation, and start-up. Provide a project specific organizational chart with complete contact information. Provide technical resumes for each member of the project team proposed for this project.

    f. The Contractor shall be an authorized and factory trained installer for the BAS proposed for this project. The BAS manufacturer shall provide written authorization of Contractor. Document this authorization.

    g. The Contractor shall not be an exclusive installer for the BAS product line proposed. The BAS manufacturer shall provide written statement of multiple specialized installer in the 50-mile radius area. Document this condition.

    h. Documentation to have three (3) reference projects where past BAS projects were on-line and functional such that the EOR can observe the BAS in full operation at the time of the project check-out. References shall include contact name and phone number.

    i. Documentation to have direct installation experience with ASHRAE/ANSI BACnet 135-1995. Project reference shall include contact name and phone number.

    j. The Contractor shall provide a building automation system that meets contract documents. Provide a riser diagram of the proposed BAS including the manufacturer's part numbers of individual DDC controllers. Submit product data information sheets for each model of DDC controller identified on the BAS riser diagram.

k. Provide a project schedule for this BAS installation including significant tasks and milestones.

l. The Contractor shall use certified electricians to install the BAS and pipefitters to install the pneumatic control components. Document the experience of these skilled trades and any Contractor employee to be used for this portion of the work.

B. BAS Manufacturer Experience

1. The Contractor shall provide building automation system products from manufacturers regularly engaged in the production of specialized building automation systems for the HVAC industry. The Contractor shall submit in writing the years of experience they have with the pre-approved manufacturer's product line for review by the EOR.

C. Products

1. Building automation system DDC controllers shall be the products of manufacturers regularly engaged in the production of specialized building automation control systems for the HVAC industry. Building automation system products shall be the manufacturer's latest standard design that complies with the contract document requirements. DDC controllers and system components shall be current production products at time of submittal; Prototypes, Beta or other non-current product offerings shall not be accepted.

2. For the Owner's future flexibility, all building level and field level controllers (e.g. BC, AAC, ASC, etc) shall be available through a non-exclusive contractor. No Exception.

3. All other project materials and equipment shall be the products of manufacturers regularly engaged in production of materials or equipment for building automation systems. The products shall be the manufacturer's latest standard design that complies with the contract document requirements. Where two or more units of the same equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of a single manufacturer. Each component product shall have the manufacturer's name, city, model and serial number permanently attached on the product.

D. Quality Assurance Program

1. The Contractor shall implement a pro-active Quality Assurance Program. This program shall consist of the following minimum requirements. The Contractor shall be fully responsible for compliance with the installation standards and system requirements as defined herein.

a. The Contractor shall assign a single individual, the Quality Assurance Manager, to be responsible for the management of the Quality Assurance Program.

b. The Quality Assurance Manager shall submit to the EOR documentation of:

1) Training for employees, both office and field, and subcontractors, on the Quality Assurance Program.

2) Written verification that each worker on the project has read the contract document sections outlining the project requirements for their area of specialty. No work shall be performed by any individual or company until this requirement has been met.

3) A detailed audit trail for all Quality Assurance issues including: problem ID number, date of original problem report, name of individual initiating report, individual assigned responsibility for resolving the problem, all

correspondence related to the problem, and final problem resolution shall be submitted to the EOR by the Quality Assurance Manager.

c. Each individual team member shall be responsible for identifying and reporting Quality Assurance problems and for assisting, as requested by the Quality Assurance Manager, in the resolution thereof.

d. Resolution of all Quality Assurance issues shall be at the Contractor's expense.

e. The Quality Assurance Manager shall submit copies of all Quality Assurance Audit Record entries to the EOR. All Quality Assurance related correspondence shall include the problem ID number.

2. The EOR shall have full audit authority over the Contractor's Quality Assurance Program. The Contractor shall retrain or remove from the project any individual identified by the EOR whose workmanship is below acceptable quality standards. All quality control decisions by the EOR are final.

1.6 CODES AND STANDARDS

A. City of Chicago Electrical and Energy Conservation Code

B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standards:

1. 90.1: Energy Standard for Buildings except Low-Rise Residential Buildings.
2. 62.1: Ventilation for Acceptable Indoor Air Quality.
3. 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks, current version including all annexes and addenda.
4. 55: Thermal Environmental Conditions for Human Occupancy.

C. Electronics Industries Alliance:

1. EIA-709.1-A-99: Control Network Protocol Specification.
2. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification.
3. EIA-232: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
4. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes.
5. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
6. EIA-472: General and Sectional Specifications for Fiber Optic Cable.
7. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications.
8. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications.
9. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications.
10. EIA-852: Tunneling of Component Network Data over IP Channels.

D. Federal Communications Commission (FCC), FCC Part 15 - Rules

E. Underwriters Laboratories

1. UL 916: Energy Management Systems.

F. NEMA Compliance

1. NEMA 250: Enclosure for Electrical Equipment.
2. NEMA ICS 1: General Standards for Industrial Controls.

G. NFPA Compliance

1. NFPA 90A: "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
2. NFPA 70: National Electrical Code (NEC).

H. Institute of Electrical and Electronics Engineers (IEEE)

1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems.
2. IEEE 1428: Guide for Installation Methods for Fiber Optic Cables
3. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN.
4. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN.

1.7 DEFINITIONS

A. The following serves as a general guide of definitions:

1. Adjustable (ADJ) or (A): A characteristic of a control logic parameter such that it can be varied by the operator without downloading the program.
2. Field Adjustable (FA): A characteristic of a control logic parameter such that it can be varied by a high level/senior programmer only.
3. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications. A fully programmable control module. This control module shall be capable of certain advanced features found in Building Controllers (e.g. storing trends, and initiating read and write requests) but it shall not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet. A BACnet device to be used as an AAC will meet the requirements of ASHRAE 135, Annex L and will be listed as an AAC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.
4. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). A pre-programmed control module, intended for use in a specific application. ASCs shall have limited configurability, allowing the user to select various pre-programmed options, but it shall not be fully customizable. A BACnet device used as an ASC will meet the requirements of ASHRAE 135, Annex L and will be listed as an ASC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.
5. BACnet/BACnet Standard: BACnet communication requirements, as defined by ASHRAE/ANSI 135, current version including all annexes and addenda.
6. Building Controller (BC): A fully programmable control module capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the BAS. A BACnet device to be used as a BC shall meet the requirements

of ASHRAE 135, Annex L and will be listed as a BC by BACnet Testing Labs. A BTL listed device will carry the BTL Mark.

7. Control System Server (CSS), Web Server (WS): Provides access to the control system. This device will allow access to the control system with a web browser over the Owner's network. As the BAS network devices are stand-alone, the CSS is not required for communications to occur. The webserver will have two NIC cards so that is functions as the bridge between the local supervisory LAN and the Owner.
8. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic
9. Stand-Alone Controller: A stand-alone controller has provisions for all of the physical inputs and physical outputs associated with a single mechanical component such as a terminal unit, air handling unit, chiller or boiler. The controller shall also have embedded in it all of the control logic that associated the physical inputs to the physical outputs. A stand-alone controller may rely on other networked devices for time schedule inputs and trend data storage.
10. Supervisory Logic: The concept of gathering performance data from multiple terminal units to determine if a specific condition exists within the family of terminal devices.

B. See also 23 09 25 – BAS_GENERAL SEQUENCE" for additional definitions.

1.8 FUNCTIONAL INTENT

A. Where detailed functional or performance requirements are specified, products intended for the Project, conforming to the specified requirements, must be submitted to, and approved by, Owner prior to shipment to the Project site.

1.9 SUBMITTALS

A. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.

1. Drawings and Diagrams: Shop drawings shall be provided on electronic media as an AutoCAD drawing file and/or Adobe Portable Document Format (PDF) file. All 'X-Reference' and font files must be provided with AutoCAD files.

2. Other Submittals: All other submittals shall be provided in Adobe PDF. Provide documents, such as Cheat Sheets and Trouble Shooting Guide, in rich text format (RTF) or Microsoft Word format as required.

3. A statement of BACnet compliancy shall be provided in the O&M documentation.

4. Where applicable, any deviations against the design intent shall be summarized with associated description of said deviation and itemized with an associated credit for final approval. Deviation(s) not listed and submitted may warrant an automatic rejection.

5. All sequences shall be reviewed with thought and care with respect to programming needs for the specific project's design. Insufficient or generic sequence details may warrant an automatic rejection.

6. Generic, non-compliant submittals shall not be reviewed, and shall be returned for resubmittal.

7. BAS Contractor shall not order material, begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. BAS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

8. It is the contractors' responsibility to coordinate and allow adequate time for an approval process. Where an expedited submittal review is required, the contractor(s) shall still be responsible for any associated project delays and pay all additional services incurred by the design engineer, at the design engineer's current standard rate.

9. The design engineer shall perform no more than two reviews of each submittal item. Should the submittals not be acceptable after the second review, the Contractor shall pay all additional expenses incurred by the design engineer in reviewing additional submittals at the design engineer's current standard rate.

10. At the time of the 23 09 00 series submittal, the BAS Contractor shall submit a copy of the following sections directly with a response of "comply" or "non-comply" for every bullet point for:

    a. 23 09 20, Section 1.9 "SUBMITTALS"

    b. Entirety of the 23 09 00 series and sub-sections, upon further request

B. Shop Drawings: Submit shop drawings for each control system, including a complete drawing for each major air distribution equipment, central hydronic system, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall contain the following information:

1. System Architecture and System Layout:

    a. One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, terminators, ground locations etc. shall be located on the diagram.

    b. Provide floor plans locating all control panels, workstations, servers, LAN interface devices, gateways, repeaters, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.

2. Schematic Flow Diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include contractor written description of sequence of operation per Schematic Flow Diagram.

3. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table per Schematic Flow Diagram.

4. Provide dedicated shop drawings of all space sensors/thermostats, OA sensors, hydronic/duct/building static pressure sensors, and workstation for final EOR and AOR review.

5. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet

backbone network number, network number, device ID, object ID (object type, instance number). See Division 23 Section "Building Automation System (BAS) - Software and Programming" PART 3 for additional requirements.

6. Label each control device with initial setting.
7. Label each input and output with the appropriate range.
8. Provide a Bill of Materials with each schematic for each equipment or system. Indicate each device in a spreadsheet with the following information:
    a. Unique device identification to match schematic and actual field labeling
    b. Quantity
    c. Part number
    d. Manufacturer
    e. Description
    f. Voltage Range (as applicable)
    g. Pressure Range (as applicable)
    h. Temperature Range (as applicable)
9. Control Valve Schedules: Provide a valve and the associated actuator information in a spreadsheet schedule. The schedule shall include a separate line for each valve and a column for each of the following valve attributes in the order presented here (no omissions):
    a. Valve Tag
    b. System (e.g.: HW Plant, Steam Plant, AHU-X)
    c. Service (e.g.: CHW, HW, Bypass, Isolation)
    d. Piping System Pressure Rating
    e. Design Body Pattern (e.g.: straight thru, mixing, diverting)
    f. Design Pipe Size
    g. Design Valve Flow Rate (GPM or lbs/hr)
    h. Design Valve Pressure Drop (PSI)
    i. Design Valve Cv
    j. Adjusted Pipe Size (actual from submittals/shop drawings)
    k. Adjusted Valve Flow Rate (GPM or lbs/hr) (actual from submittals)
    l. Adjusted Valve Pressure Drop (PSI) (actual from submittals)
    m. Adjusted Calculated Valve Cv (provide formula and coefficient values)
    n. Selected Valve Cv
    o. Selected Valve actual Pressure Drop (in PSI),
    p. Selected Manufacturer
    q. Selected Part Number

r. Body Style (e.g. globe, butterfly, ball, eccentric, high-performance, pressure independent)

s. Selected Size (in inches)

t. Pipe Connections (sweat, screwed, flanged)

u. Actuator Fail Position Flow Pattern (de-energized) (e.g.: open, closed, last position)

v. Actuator Model Number

w. Actuator Working Range (e.g.: Volts, mA or PSI)

x. Actuator Close-Off Pressure (against system)

y. Coordination sign-off sheet with a list of the referenced equipment submittal and/or shop drawing. Reference shall include equipment tag and date of utilized equipment submittal.

z. Comments.

10. Control Damper Schedules: Provide a damper and its associated actuator information in a spreadsheet type schedule. The schedule shall include a separate line for each damper and a column for each of the following damper attributes in the order presented here (no omissions);

a. Damper Tag

b. System (e.g.: AHU, Electrical Room, Combustion)

c. Service (e.g.: Min_OA, OA, CAI, Intake, Exhaust, Isolation, Sub Zone)

d. Opening Size (W x H)

e. Design Flow Rate (CFM)

f. Design Velocity (FPM)

g. Selected Damper Size (W x H)

h. Section Labels & Sizes (W x H)

i. Manufacturer

j. Part Number

k. Blade Pattern (parallel, opposed, single)

l. Blade Type (e.g. air foil, two piece)

m. Bearing Type

n. Fail Position (de-energized)

o. Actuator Model Number

p. Actuator Quantity

q. Actuator Working Range (Volts, mA or PSI)

r. Actuator Mounting Location (electronic; shaft, sleeve-out collar, channel support

s. Damper Closing Torque

t. Actuator Rated Torque

u. Damper Close-Off Pressure (against system)

v. Leakage and flow characteristics charts shall be submitted for review.

w. Submit diagram for each damper of three or more sections wide showing the position of each section and associated actuator mountings.

x. Coordination sign-off sheet with a list of the referenced equipment submittal and/or shop drawing. Reference shall include equipment tag and date of utilized equipment submittal.

y. Comments

11. Air Flow Measuring Station Schedules: Spreadsheet type schedule shall include a separate line for each flow station and a column for each the following station attributes in the order presented here (no omissions);

a. Station Tag

b. System

c. Service

d. Opening Size (W x H)

e. Design Flow Rate (CFM)

f. Design Velocity (FPM)

g. Selected Station Size (W x H)

h. Section Labels & Sizes (W x H)

i. Station Manufacturer

j. Station Part Number

k. Velocity Pressure Sensor Range

l. Velocity Pressure Sensor Manufacturer

m. Velocity Pressure Sensor Part Number

n. Coordination sign-off sheet with a list of the referenced equipment submittal and/or shop drawing. Reference shall include equipment tag and date of utilized equipment submittal.

o. Comments

12. Indicate all required electrical wiring; include ladder logic type diagram (for motor starters, boiler, chiller, RTU, control, and safety circuits). Ladder diagrams shall appear on system schematic.

13. Indicate all required electrical wiring; include detailed factory digital point termination diagrams with all wire numbers and terminal block numbers identified. Panel termination drawings shall appear on separate drawings. Clearly differentiate between portions of wiring, which are existing or factory-installed versus field-installed points.

14. For all devices with safety circuits (e.g. burners and chillers), field wiring shall be labeled and all added devices shall be properly mounted. Any internal wiring changes shall be approved by the manufacturer in writing. If for example, a gas booster needs to be tied into the burner circuit the manufacturer shall identify the terminal points and provide an updated control diagram.

15. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
16. Sheets shall be consecutively numbered.
17. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
18. Table of Contents listing sheet titles and sheet numbers.
19. Legend and list of abbreviations.
20. Provide an operating schedule for review. The schedule shall have a schedule for each major equipment and their associated equipment.
21. Terminal units serving private zones shall have a separate schedule from public areas.
22. Initial Graphical User Interface screens for each unique type of system shall be included as an appendix. Include display screen to be provided, data to be displayed, and links to other screens. Outline level hierarchy shall be:
    a. Site
    b. Building
    c. Floor
    d. System
    e. Parameters
    f. Schedules
    g. Histories
    h. Etc.
23. Final Graphical User Interface screens for each unique type of system shall be received 60 days prior to system startup.

C. Product Data:

D. Product Data: manufacturer technical information shall be provided after the BAS shop drawings. BAS contractor shall present the technical information in a user-friendly manner and organization.

1. Provide a summary index of all catalog cut sheets included. Index shall precede cut sheets and list the order of the cut sheets.
2. Include, but is not limited to DDC panels, OWS, portable operator terminals, sensors, actuators, dampers, valves, control air system components, etc. Provide range and scale information for all transmitters and sensors.
3. For each control device, panel, and accessory indicated or furnished. Include dimensions, capacities, performance limits, electrical characteristics, and material finishes.
4. Include installation and start-up instructions.
5. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate via highlighter, rectangle or circle on each sheet the specific device selected and applicable options. Non-compliance shall warrant an automatic rejection.
6. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

E. Product Line Demonstrated History: The product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of one (1) year since date of final completion in at least ten (10) installations of comparative size and complexity. Submittals shall document this requirement with references.

F. Testing Plan:

1. Submit a plan for executing all phases of testing and completion of checkout forms. This includes the following: manufacturers' normal testing, point-to-point testing, pre-functional testing, and functional performance testing. The testing plan shall show the overall milestones of the controls work and testing of the controls system.

2. Provide the schedule for completing each phase of testing for each system or set of equipment including, but not limited to, air handlers, chillers, boilers, unit-vents, VAV boxes, network wiring, and operator workstations. Schedules shall show the time frame needed to complete the tasks.

3. The testing plan shall identify other trade milestones that impact the successful completion of during each phase of testing.

4. This plan is not meant to take precedence over any other plan but is intended to provide coordination assistance to all trades as the project is scheduled.

G. Checkout and Testing Forms: Submit a blank copy of the forms that shall be used during Point-to-Point Checkout, Prefunctional Checkout, and Functional Performance Testing as outlined in Division 23 Section" Building Automation System (BAS) - Commissioning." Those forms should be structured to capture the following information at a minimum during each particular testing phase.

1. Point-to-Point Checkout Form containing the following information:

a. Each point is addressed, labeled and that proper communication exists between the controller and the field device.

b. Documents that installed condition match the control drawings and that any changes or differences are noted on the drawings.

2. Prefunctional Checkout Forms containing the following information:

a. Documents correct voltage and or current present as well as verifying circuits are free from grounds or faults for each control device.

b. Obtain and Record Test and Balance settings and incorporate into the BAS. Information from the TAB contractor shall include:

1) Water and air system differential pressure and flow settings.

2) AHU minimum outside air control point or damper setting.

c. Calibration data for all sensing and actuating devices recording final measured and displayed value. Record the type and model of the meter(s) that determined the measured value for analog inputs.

d. For analog outputs record both the displayed output as well state of the receiving device.

e. For digital input/outputs record the signal at the controller and the state of the sensing/control device.

f. For actuators:

1) Check to ensure that actuated device moves smoothly and results are repeatable thru full range and seals tightly when the appropriate signal is applied to the operator.

2) Check for appropriate fail position, and that the stroke and range is as required.

3) For sequenced electronic actuators, calibrate in accordance with manufacturer's instructions to required ranges. Record final settings.

g. For all valves and actuators, verify the actual position against the Operator Interface readout. Set pumps to normal operating mode. With command valve closed, verify that valve is closed, and adjust output zero signal as required. With command valve open, verify position is full open and adjust output signal as required. Command the valve to not less than three (3) intermediate positions. If actual valve position doesn't correspond correctly, replace actuator.

h. Valve leak check: Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit.

i. For air and water flow measuring stations the data recorded shall include the independent flow measurement, area, and the independently measured output of the flow station. The BAS input from the flow station and any factors used to calculate the flow including area and any constants used in the calculation of flow. Two sets of data shall be collected. The first at design flow and the second at 50% of design flow. It is not acceptable to simply add a correction factor to address differences between the flow station and the independent reading.

j. For Operator Interfaces and Web accessible display:

1) Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.

2) Output all specified BAS reports for review and approval.

3) Verify that the alarm pop ups, printing, and logging are functional and in accordance with requirements.

4) Verify that all points are trended and are archiving to disk. Provide a sample to the Commissioning Authority and owner for review.

5) Verify that paging/dial-out alarm annunciation is functional.

6) Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.

7) Verify that required third party software applications required with the bid are installed and are functional.

k. For all actuating devices record final settings for device.

l. Document verification of point to graphics binding for all points displayed on the OWS and that webserver display have been mapped correctly, and display the correct information.

m. Document that the webserver is on LAN and can be viewed from off site, that the modem is connected, and that the BAS is accessible via modem by the contractor.

3. Functional Performance Forms shall contain:

    a. List of all sequences, modes of operation and setpoint that initiates each sequence and/or mode. For each confirm that proper sequence of operation. Document any variance between designed sequence and actual condition.

    b. Record tuning parameters and response time for each control loop.

    c. Document all alarm and safeties test and final results.

    d. Results of trends including controlled points, setpoints, actual readings, and other point defined by the Boards Authorized Representative.

H. Open Protocol Information:

1. General: Provide all information necessary for review of the proposed system, including information required by the authority maintaining the protocol standard to determine if the product selected for implementation complies with the protocol standards specified.

2. BACnet Systems:

    a. BACnet object description, object ID, and device ID, for each I/O point.

    b. Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.

    c. Documentation of all explicit messaging.

    d. Submit PICS indicating the standardized BACnet device profile, functionality and configuration of each controller along with proof of BTL listing.

I. Framed Control Drawings: After completion of installation and check out, but prior to training, laminated control drawings including system control schematics, sequences of operation, and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.

J. Control Logic Documentation:

1. Documents are to be submitted, received, and approved prior to training.

2. Submit control logic program listings (for graphical programming) and logic flow charts illustrating (for line type programs) to document the control software of all control units.

3. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.

4. Include written description of each control sequence.

5. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters, and limits.

6. Sheets shall be consecutively numbered.

7. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.

8. Include Table of Contents listing sheet titles and sheet numbers

9. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set shall count toward the required number of Operation and Maintenance materials specified below.

K. Training Plan:

1. Documents are to be submitted, received, and approved prior to training.

2. Training shall be provided for a total of (16) hours.

3. A training plan is required for opposite season or refresher training.

4. The material to be covered shall be further sub-divided into descriptions of the material to be covered in every 15 minutes. See Division 23 Section "BAS – Commissioning," for specific items to be addressed.

5. The descriptions shall include not only the material to be covered but also its location in the Operation and Maintenance Manual or the Training Manual including Section and page number.

6. Opposite Season or Refresher Training:

a. The third training session shall be conducted on-site at a date specified by the Owner within twelve months of Preliminary Acceptance or Substantial Completion and shall consist of four, four-hour sessions of training. The session shall be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

L. As Built Documentation:

1. The Contractor shall submit as-built documentation in accordance with Contract Documents.

2. Integrate with flow diagrams, show outlines of HVAC equipment with control devices, schematic one-line control piping and wiring, and reduced floor plan drawings showing installation routing of all DDC system network LANs, control panels, and power supply panels.

3. DDC wire sheets, a graphical display of DDC logic, shall be provide for every major equipment and system.

4. Equipment numbers shall correspond to those shown on the Contract Drawings. Provide As-Built drawings as follows:

a. One set of reproducible drawings

b. One set of applicable drawings placed in the plan pocket of each local control panel. System flow diagram, panel wiring diagram and points list shall be provided inside each panel housing a digital controller, except terminal units

c. Two complete flash-drive backup of the OWS.

d. Two complete flash-drive backup of all controller programs, controller software source code, database files, and configuration files.

e. Two copies of all training lecture video tapes

M. Operation and Maintenance Manual:

1. Digital documents are to be submitted, recieved, and approved prior to training.

2. Submit three (3) sets of each manual to the owner's operating staff.
3. Hardware Manual: Include the following documentation:
    a. Complete set of approved as-built submittals reflecting all updates during construction.
    b. As-Built Bill-of-Materials
    c. As-Built cut sheets for all components
    d. As-built detailed wiring, installation, and calibration procedures for each field and panel device
    e. Complete trouble-shooting procedures and guidelines
    f. Complete operating instructions for all systems
    g. Maintenance Instructions: Document all maintenance and repair/replacement procedures. Provide ordering number for each system component, and source of supply. Provide a list of recommended spare parts needed to minimize downtime.
4. Software Manual: Include the following documentation:
    a. Table of Contents
    b. Program Function Index
    c. Program Listing of Software Source Code or Flow Chart Diagrams of Programming Objects. For control systems using either compiled program code or interpreted code provide source code of all programs and function libraries to be installed. For systems using a graphical object orientated programming environment, provide a computer plotted flow chart showing the interconnection of the programming objects and all associated parameters. A copy of the flow chart shall be provided on disk or CD-ROM and in hard copy format.
    d. Printed listing of controller and OWS database files
    e. Submit BAS advanced Programming Manuals for each controller type and for all OWS software.
    f. Appendix A: Alphabetical Software Point Name Abbreviation List. Include Name, Description, Controller Where Located, Point Type and Point ID
    g. Appendix B: Alphabetical I/O Point List. Include Point Name, Controller Location, Point Number, Control Device, Range and Span
    h. Appendix C: Sample printouts of all; Reports, Group Listings and Alarm Messages
    i. Alphabetical Index of all DDC point names with documentation manual page number references
5. Provide three (3) copies of all manufacturers manuals covering the installed system. This shall include, as a minimum:
    a. System Engineering Manual
    b. System Installation Manual
    c. Programming Manual
    d. Engineering and Troubleshooting Bulletins

e. Operator Workstation Software Manual

f. All other pertinent manuals published by the control system manufacturer

g. All manuals shall be provided in hard copy format and as part of an On-Line documentation system through the OWS.

6. Comply in accordance with requirements of Division 01 Sections.

N. Training Manual: Submit training manual electronically for review. Once accepted, provide three hard copies and one electronic copy of the training manual at the start of training. Include the following:

1. Cheat Sheets or quick reference section with step-by-step guidance with a level of detail that shall allow someone with no experience with the control system to follow the instructions. The quick reference guidance can be provided one of two ways: screen prints with bubbled text describing the navigation required or written description of the steps to be taken with screen prints provided to facilitate the written explanation. The required cheat sheets shall include:

a. Logins and logoffs.

b. Adjust and restore setpoints.

c. Overrides and releasing overrides. Include instructions for running a report to list all points currently overridden.

d. Start, group, plot and export Trends.

e. Adjust schedules and add holidays.

f. Processing of alarms including acknowledgement, review of alarm report, and clearing of alarm history.

g. Backup and restoration of system data.

h. Demonstrate how to clear/reset all field devices that may require manual intervention.

i. Demonstrate how to reset motor starter and the significance of Hand-Off-Auto switch position on motor starters.

j. Demonstration of each input and output device. Provide a picture of each input or output device with a brief narrative on its operation.

k. Demonstrate how to place the boiler or chiller system into manual control and boiler control, and how to restore the system to BAS control.

2. Operating instructions including system startup and shutdown, seasonal and emergency instruction.

3. Trouble Shooting Guide. Include actions to be taken to trouble shoot problems with the OWS, PCU's CSS, and local control devices.

4. Setpoint Table.

5. Preventative maintenance instructions.

6. Color print of each unique screen.

7. Final Sequence of Operations. This document shall be printed but shall also be provided electronically in rich text format (rtf). The sequence shall provide not only the original

design sequence from the contract documents and drawings but also the any changes to the sequence.

8. Complete set of the design control drawings (provided by the Architect on 11"x17" sheets). The manual shall have a TAB for these drawings. The printed drawings shall come from the Architect or Engineer.

9. List of all alarm points and alarm priority.

O. Video Training: The following training shall be recorded on a CD using screen capture software. Any files required to run the CD shall be provided. The cadence of the video training shall be such that an inexperienced person can listen to the narrative and execute those steps on controls system while watching the CD. Include a screen view recording the actual video feed to the monitor for the workstation penetration while narrating the associated steps.

1. Quick reference procedures. The taping of these procedures must include both a screen view preferably recording the actual video feed to the monitor while narrating the associated steps.

a. Login and logoff to control system as well as Microsoft XP login;

b. Adjust and restore setpoints.

c. Overrides and releasing overrides, as well as running a report to list all points currently overridden.

d. Start, group, plot and export Trends.

e. Adjust schedules and add holidays.

f. Processing of alarms including acknowledgement, review of alarm report and clearing of alarm history.

g. Backup and restoration of system data.

h. Demonstrate workstation menu penetration and broad overview of the various workstation features.

i. Demonstrate all operations and functions that can be performed at the supervisory or local controllers as well as system display artifacts such as the indication that a point has failed or lost communication.

P. Demonstration of portable operator interface device display capabilities.

Q. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance.

R. Refer to specification 23 09 20, section 1.13 for Warranty requirements.

1.10 PROJECT RECORD DOCUMENTS

A. The Project Record documents that have not already been submitted as part of the Operating and Maintenance Manual or Training Manual are to be submitted with the Record Documents. Any documents in the Operating and Maintenance Manual or Training Manual that have changed since they were submitted shall need to be re-submitted as part of the Project record documents. All these documents maybe submitted electronically.

B. Record copies of product data and control shop drawings updated to reflect the final installed condition.

C. Record copies of approved control logic programming and database on tagged CDs or USB flash drives. The CDs or USB flash drives shall contain all information required to reinstall the control system program. It shall include actual final setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing. One set of CDs or USB flash drives shall be stored at the building in the main control panel and the second set shall be provided to Owner's facilities department.

D. Graphic Software: Record copies of approved project specific graphic software on flash drive.

E. For BACnet systems provide as-built network architecture drawings showing all BACnet nodes including a description field with specific controller identification, description and location information.

F. DDC wire sheets, a graphical display of DDC logic, shall be provide for every major equipment and system.

G. Include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.

H. Provide record riser diagram showing the location of all controllers.

I. Refer to specification 23 09 20, section 1.13 for Warranty requirements.

1.11 OPERATOR INTERFACE

A. The Operator Interface (OI) shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, remote monitoring, and trend reporting. Refer to Division 23 Section" Building Automation System (BAS) - Operator Interfaces."

1.12 SYSTEM ARCHITECTURE

A. Application of Open Protocols:

1. Subject to the detailed requirements provided throughout the contract documents, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing the following standards:

a. BACnet or Hybrid System: The system architecture shall consist of a BACnet IP Router, a single Local Area Network (LAN) or two-level LANs that support BCs, AACs, ASCs, OWS, Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. In no event shall there be more than two levels of LAN topology within the system, excluding wiring to sensors with no control intelligence.

B. The system provided shall incorporate hardware resources sufficient to meet the functional requirements specified. The Contractor shall include all items not specifically itemized in the contract documents that are necessary to implement, maintain, and operate the system in compliance with the functional intent of the contract documents.

C. The system shall be configured as a distributed processing network(s) capable of expansion as specified below. Refer to the network architecture on the BAS drawings for other requirements and details.

D. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-leveled LANs that support PCUs, Operator Workstations

(OWS), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.

1. Owner WAN: Intranet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and contractor is not required to configure any components of this WAN.

2. Local BAS Supervisory LAN: The Local BAS Supervisory LAN shall be an Ethernet-based, 100 Mbps LAN connecting Primary Control LANs and OWSs. The LAN serves as the inter-PCU gateway and OWS-to-PCU gateway and communications path and as the connection point for the Owner WAN. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 5 cable with switches and routers that support 100 Mbps throughput. Power- line carrier communication shall not be acceptable for communications. The higher level layers of this network shall be BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet.

   Primary Controller LAN ('Primary LAN'): High-speed, peer-to-peer communicating LAN used to connect and Primary Control (PCUs) and communicate exclusively control information. A BACnet network shall be used to connect AACs, ASCs or SDs. These can be Master Slave/ Token Passing or polling, or ARCnet in accordance with IEEE 802.4, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements. The primary network shall communicate at a minimum of 38 kbps. Each secondary network may support up to 32 communicating devices without segmentation or repeaters subject to the requirements for response time, trending and bandwidth utilization.

E. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.

F. Remote Data Access: The system shall support the following methods of remote access to the building data.

1. Browser-based access: A remote user, connecting via the Owner WAN and using a standard browser shall be able access all control system facilities and graphics with proper password. The remote access user shall not need to load applications to view the web pages.

G. Network Performance: The communication speed between the controllers, control LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with shop drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements. The performance shall also include the trending of all AI, AO and DI points at 15-minute intervals. Generally requirements do not apply when a remote connection must be established via modem:

1. 5 seconds between a Level 1 (critical) alarm occurrence and annunciation at the OWS.

2. 10 seconds between a Level 2 alarm occurrence and annunciation at the OWS.

3. 20 seconds between and a Level 3-5 alarm occurrence and annunciation at the OWS.

4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.

5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.

6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.

7. Graphic Display, 10 seconds between an operator selection of a graphic and it completely painting the screen and updating all points.

8. Graphic Refresh, every 15 seconds the graphic shall automatically refresh all graphic data.

H. Control Systems Server (CSS) and Operator Work Station (OWS):

1. These are computers that maintain the systems configuration and programming database and is the operating platform for the operator interface (OI).

2. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers.

3. It shall be located within each facility.

4. It shall also act as a control information server to non-control system based programs.

5. It shall allow secure multiple-access to the control information.

6. Refer to Division 23 Section" Building Automation System (BAS) - Operator Interfaces," for requirements.

I. The PCUs shall monitor, control, and provide the field interface for all points specified. Each PCU shall be capable of performing all specified energy management functions, and all DDC functions, independent of other PCUs and operator interface devices as more fully specified in Division 23 Section" Building Automation System (BAS) - Field Panels."

J. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server or OWS on the Local Supervisory LAN. User tools provided to Owner shall allow configuring, updating, and maintaining current configurations and settings whether they are initiated at the server or the end device.

1. Database Schema shall be published and provided to Owner to facilitate easy access to the data.

2. Database shall be ODBC compliant or a data access driver shall be provided to act as an ODBC or OLE DB data provider.

K. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.

L. All line drivers, repeaters, terminators, signal boosters, and signal conditioners shall be provided as necessary for proper data communication.

M. Anytime any controller’s database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the OWS and CSS.

1.13 WARRANTY PERIOD

A. Contractor shall warrant all hardware and labor for a period of one (1) year after Final Acceptance.

B. Contractor shall warrant all meters for a period of two (2) year after Final Acceptance.

C. Contractor shall warrant automatic software update for a period of five (5) year after Final Acceptance.

D. If a product that was installed does not comply with the listed pre-approved product, manufacturer or contractor, all related product and labor shall automatically escalate to a 5-year warranty at no cost to the owner, architects, or design team.

E. After completion of the installation, the Contractor shall adjust all control equipment and software provided under this Section. If within the warranty period any of the control equipment and software is defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted, at no cost to the Owner.

F. The Owner reserves the right to make changes to the BAS during the warranty period. Such changes shall not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.

G. At no cost to the Owner during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:

1. Preventative Maintenance services shall be provided for all devices and hardware specified in Division 23 Section" Building Automation System (BAS)" Sections. Service all equipment per the manufacturer's recommendations. All devices shall be calibrated within the last month of the warranty period.

2. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by Owner to the Contractor.

    a. Response by telephone to any request for service shall be provided within eight (8) working hours (contractor specified 40 hr/week normal working period) of the initial telephone request for service.

    b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the site within three (3) working days of the initial telephone request for such services, as specified.

3. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by Owner to the Contractor.

    a. Response by telephone to any request for service shall be provided within two (2) hours of the initial telephone request for service.

    b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the site within eight (8) hours of the initial telephone request for such services, as specified.

c. Emergency service shall be available on a 24-hour, 7-day-a-week basis.

4. Telephonic Support: Contractor shall provide up to three telephone numbers for Owner to call in the event of a need for service. At least one of the lines shall be attended 24 hours a day, 7 days a week. Alternatively, emails can be used for technicians trained in system to be serviced. A technician shall respond to every call within 15 minutes.

H. Product Warranty Certificates: Submit product manufacturers and/or representative's warranty certificates covering the hardware provided.

I. Project Record Documentation: Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period.

1.14 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

1.15 LISTING AND LABELING

A. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

B. BACnet controllers, B-BC, B-AAC, B-ASC, etc. shall carry the BTL Mark for their device profile.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials shall be new, the best of their respective kinds without imperfections or blemishes, and not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where drawings or specs specifically allow existing materials to remain in place.

B. Instrumentation required to verify readings and test the system and equipment performance shall be provided by the Contractor. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

C. Refer 23 09 00 series sub-section "BAS – Control Materials" for requirements.

2.2 UNIFORMITY

A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Factory/Owner Acceptance Test: a test shall be conducted by this contractor with the owner and designer with a minimum of three months prior to onsite installation. The intent of this verification/approval is to determine that all custom built panels, programs, graphical user interface screens, PID loops for hydronic and airside controls comply with contract documents and construction codes. Approval by Owner and EOR are required prior to installation. All delays incurred due to non-compliance shall be at the cost of this contractor.

C. If any material were procured or installation was started prior to an approved BAS submittal by the designer and owner, any corrections shall be resolved at no cost to the design team or owner. All implicated delays incurred due to non-compliance shall be at the cost of this contractor.

D. If the work fails to be demonstrated to conform to Contract documents, so as to require scheduling of additional site visits by the EOR and/or owner for re-demonstration, Contractor shall reimburse EOR and/or Owner for costs of subsequent site visits.

E. Where a discrepancy exist among details, schematic, construction documents, or sequence, the most stringent shall apply to complete a fully functional system.

3.3 DIGITAL CONTROL STATIONS, CONTROLLER QUANTITY AND LOCATION

A. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements specified.

B. Where a DCS is referenced, Contractor shall provide at least one (1) enclosure, one (1) controller, and additional controllers as required and in sufficient quantity to meet the requirements of the contract documents. Restrictions in applying controllers are specified in 23 09 00 series sub-section "Building Automation System (BAS) - Field Panels".

C. This Contractor shall extend power to the DCS from an acceptable power panel. If the contractor wishes to further distribute panels to other locations, contractor is responsible for extending power to that location also. Furthermore, contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.

D. Contractor shall locate DCSs as required. It is the Contractor's responsibility to provide enough controllers and enclosures to ensure a completely functioning system, according to the point list, trending requirements and sequence of operations. Contractor shall coordinate with other trades for

E. Contractor shall provide the following, as a minimum:

1. One DCS (enclosure & controller) in each hydronic plant's mechanical room.
2. One DCS (enclosure & controller) for each air handler (e.g. AHU, MUA, RTU).

3. One DCS (enclosure & controller) for each unitary equipment (e.g. ERV, UV, FCU, Manifolds).

4. One DCS (enclosure & controller) for each group of equipment within a 50-ft radius (e.g. EF, radiant manifolds, meters, miscellaneous monitoring).

5. One controller shall be provided for each terminal unit with factory enclosure.

3.4 SURGE PROTECTION

A. The Contractor shall furnish and install any power supply surge protection, filters, and other equipment as necessary for proper operation and protection of all PCUs, operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no affect on hardware, software, communications, and data storage.

3.5 CONTROL POWER SOURCE AND SUPPLY

A. Extend all power source wiring required for operation of all equipment and devices provided under Division 23 Building Automation System (BAS) Sections and Sequences of Operation.

1. Control panels shall not share a power circuit. Power supplied to the panels shall have dedicated circuits and the circuit location shall be documented in the panel.

3.6 STARTUP, COMMISSIONING, AND TRAINING

A. Refer to Division 23 Section "Building Automation System (BAS) - Commissioning."

B. At the direction of the engineer during construction, testing implementation, and/or after acceptance, allow for a minimum of 20 hours of application programming modifications to the sequence of operation to accommodate tuning of controlled system devices to match intended functional performance.

3.7 SEQUENCE OF OPERATION

A. Refer to Division 23 Section "Building Automation System (BAS) - Sequences of Operation."

3.8 IDENTIFICATION STANDARDS

A. Controller Identification. All controllers shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.

B. Panel Identification. All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.

C. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label.

D. Panel Devices. All panel devices shall be identified by a typed label securely fastened to the backplane of the local control panel.

E. Raceway Identification. All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.

F. Wire Identification. All low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed

END OF SECTION

SECTION 23 09 21

BUILDING AUTOMATION SYSTEM (BAS) - BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Pneumatic Tubing.
2. Wiring.
3. Control Valves and Actuators.
4. Field Panels.
5. Sensors.
6. Electric Control Components (Switches, EP Valves, Thermostats, Relays, Smoke Detectors, etc.).
7. Transducers.
8. Specialty Gas Detection.
9. Current Switches.
10. Nameplates.
11. Testing Equipment.

1.2 DESCRIPTION OF WORK

A. Refer to Division 23 Section "Building Automation System (BAS)" for general requirements.

B. Refer to other Division 23 Sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this Section.

C. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections:

1. Control wiring between field-installed controls, indicating devices, and unit control panels.
2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
3. Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.
4. All other necessary wiring for fully complete and functional control system as specified.
5. Power wiring from spare circuits in electrical panels to Digital Control System Field Panels.

D. Warranty Period: Refer to specification 23 09 20, section 1.13 for Warranty requirements.

1.3 COORDINATED WORK WITH OTHERS

A. BAS contractor shall provide written coordination on capacity, performance, and location on all devices that require installation by trade contractor during the 230920 submittal phase.

B. AFMS that may be factory-installed require written coordination with sign-off during the 230920 submittal phase.

C. Automated Control Valves shall be furnished under this Section and shall be installed under the applicable piping Section under the direction of the Digital Control System Contractor who shall be fully responsible for the proper operation of the valve.

D. Control Dampers furnished under this Section shall be installed under the applicable air distribution or air handling equipment Section under the direction of the Digital Control System Contractor who shall be fully responsible for the proper operation of the damper

E. Water Pressure Taps, Thermal Wells, Flow Switches, Flow Meters, etc. that will have wet surfaces, shall be installed under the applicable piping Section under the direction of the Digital Control System Contractor who shall be fully responsible for the proper installation and application.

F. Controlled Equipment Power Wiring shall be furnished and installed under Division 26. Where control involves 120V control devices controlling 120V equipment, Division 26 Contractor shall extend power wiring to the equipment. Building Automation System Contractor shall extend it from the equipment to the control device.

G. BAS Contractor shall provide adequate time to coordinate and work with Equipment Manufacturer where factory-controls are provided to achieve the design sequence of operations.

H. BAS Contractor shall provide adequate time to coordinate and work with Test and Balancing Contractor to achieve the design sequence of operations.

I. If coordination has been neglected or failed to occur, the BAS contractor shall provide the required design intent device and trade contractor shall install said device at no cost to the owner and designers.

PART 2 - PRODUCTS

2.1 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into BACnet controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It shall be this contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, designed to work with ‘two-wire’ type transmitters, if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

F. Acceptable manufacturers: No exceptions shall be acceptable post bid without the EOR’s approval.

2.2 MATERIALS AND EQUIPMENT

A. General: Provide electronic control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

B. Conduit: All conduit shall be in accordance with the most stringent of National Electrical Codes, Local Electrical Codes, Division 23, and Division 26 of the contract documents.

C. Communication Wiring: All wiring shall be in accordance with National Electrical Codes and Division 26 of the contract documents.

1. Contractor shall supply all communication wiring between Building Controllers (BC), Routers, Gateways, Advanced Application Controllers (AAC), Application Specific Controllers (ASC) and local and remote peripherals (e.g., operator workstations, printers, and modems).
2. Local Supervisory LAN: For any portions of this network required under this Section of the specification, contractor shall use Fiber or Category 5 of standard TIA/EIA 68 (10BaseT).
3. Network shall be run with no splices and separate from any wiring over thirty (30) volts.
4. Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over thirty (30) volts. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.

D. Control Panels: Provide control panels with suitable brackets for wall mounting for each control system. It shall be the Contractor’s responsibility for coordination with other trades for space clearance, elevation, and power requirements. Contractor shall provide and locate panels adjacent to systems served.

1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop- painted finish and color.
2. Provide UL-listed cabinets for use with line voltage devices.
3. All gauges and control components shall be identified by means of nameplates.
4. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
5. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.
6. All panels shall be RoHS compliant.

E. Signal Wiring: Contractor shall run all signal wiring in accordance with National Electric Codes and Division 26 of the contract documents.

1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover.
2. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
3. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

F. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 26 of the contract documents.

1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated.
2. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

G. Instrument Pipe and Tube

1. Hydronic and Instruments

a. Connection To Main Piping: Provide ½ inch minimum size threadolet, ½" x 2 inch brass nipple, and ½" ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.
b. Remote Instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼" FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.
c. Line Mounted Instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.
d. Instrument Tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing OD size shall be not less than the larger of ¼" or the instrument connection size.
e. Rigid Piping for Line Mounted Instruments: Schedule 40 threaded brass, with threaded brass fittings.

2. Low Pressure Air Instrument Sensing Lines

a. Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.
b. Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing.
c. Use compression or push-on brass fittings.

2.3 CONTROL VALVES

A. General: Provide factory fabricated 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 in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.

B. Indicate normal (fail) positions of spring return valves. This is the valve position with no power to the actuator.

C. Acceptable Manufacturers for all non-pressure independent control valves:

1. Belimo
2. Bray Control Valves
3. Johnson Control Valves

D. Ball Type: Valve shall be sized for 50 to 100% of branch pressure drop.

1. Body: Brass; one-, two-, or three-piece design; threaded ends.
2. Seat: Reinforced Teflon
3. Ball: Stainless steel.
4. Port: Standard or 'V' style.
5. Stem: Stainless steel, blow-out proof design, extended to match thickness of insulation.
6. Cold Service Pressure: 600 psi WOG
7. Steam working Pressure: 150 psi
8. Actuator: Provide 0-10V/4-20mA modulating, spring-return, with control feedback motors. No exception.

E. Characterized Ball Type

1. Body: Carbon Steel (ASTM 216), one-piece design with wafer style ends.
2. Seat: Reinforced Teflon (PTFE).
3. Ball: Stainless steel ASTM A351
4. Port: Segmented design with equal-percentage characteristic.
5. Stem: Stainless steel.
6. Cold Service Pressure: 200 psi WOG
7. Cavitation Trim: Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.
8. Actuator: Provide 0-10 V/4-20 mA modulating, spring-return, with control feedback motors. No exception.

F. Plug-Type Globe Pattern for Water Service:

1. Valve Sizing: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
2. Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage- type trim, providing seating and guiding surfaces for plug on 'top-and-bottom' guided plugs.
3. Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on 'top-and-bottom' guided plugs.
4. Temperature Rating: 25°F minimum, 250°F maximum
5. Body: Bronze, screwed, 250 psi maximum working pressure for 1/2" to 2"; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2" and larger.
6. Valve Trim: Bronze; Stem: Polished stainless steel.
7. Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
8. Plug: Stainless steel, Seat: Brass
9. Disc: Stainless Steel Filled PTFE.
10. Ambient Operating Temperature Limits: -10 to 150°F

11. Actuator: Provide 0-10 V/4-20 mA modulating, spring-return, with control feedback motors. No exception.

G. Butterfly Type: Valve shall be sized for 50 to 100% of branch pressure drop. For valves sized at 3way less than 90 degree position for pressure drop are to have the linkage for full closed when the open port is at the design point.

1. Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.
2. Seat: EPDM, except in loop bypass applications where seat shall be metal to metal
3. Disc: Bronze or stainless steel, pinned or mechanically locked to shaft
4. Bearings: Stainless steel
5. Shaft: 416 stainless steel
6. Cold Service Pressure: 175 psi
7. Close Off: Bubble-tight shutoff to 150 psi
8. Operation: Valve and actuator operation shall be smooth both seating and unseating. Should more that 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the owner.
9. Actuator: Provide 0-10 V/4-20 mA modulating, spring-return, with control feedback motors. No exception.

H. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:

I. Pressure Independent Control Valves (PICV)

1. PI valves is a control valve with a regulator valve which maintains the differential pressure across a flow control valve.
2. PI valves shall accurately control the flow from 0-100% full rated flow regardless of changes in the piping pressure.
3. PI valves shall not vary the flow more than $\pm$5% at any given flow control valve position when the PIV differential pressure lies between the manufacturer's stated minimum and maximum.
4. The rated minimum differential pressure for steady flow must not exceed 5 psid across the PIV.
5. Provide either globe or ball type valves meeting the indicated requirements for globe and ball valves.
6. Provide valves with a flow tag listing full rated flow and minimum required pressure drop.
7. Provide valves with factory installed Pressure/Temperature ports ("Pete's Plugs") to measure the pressure drop to determine the valve flow rate.
8. Actuator: Provide 0-10 V/4-20 mA modulating, spring-return, with control feedback motors. No exception.

J. Acceptable Manufacturers for pressure independent control valves only:

1. Flow Control
2. Belimo
3. Bray Control Valves

2.4 ACTUATORS

A. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as

specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.

B. Damper Actuators:

1. Ambient Operating Temperature Limits: -10 to 122°F
2. Two Position Electric Actuators: Line voltage with spring return
3. Electronic Actuators: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, as required. Actuators shall travel full stroke in less than 90 seconds, unless prior approval is obtained. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. Where two actuators are required in parallel, or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override. Modulating actuators for valves shall have minimum rangeability of 40 to 1.

    a. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close- off pressure. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent. When shutoff does not apply the actuator shall be sized based on the manufactures required torque plus 30%.
    b. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:

        1) Belimo
        2) Honeywell

C. Valve Actuators:

1. Electric

    a. Motor: Suitable for 120 or 240 Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.
    b. Gear Train. Motor output shall be directed to a self-locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
    c. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure
    d. Failsafe Positioning: Actuators shall be spring-return type or battery-powered for failsafe positioning.
    e. Enclosure: Actuator enclosure shall be NEMA-4 rated, and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.
    f. Limit Switches: Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.
    g. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
    h. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared hand-wheel type. For larger valves, the override shall be a fixed geared hand-wheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the hand-wheel is engaged for manual operation.

i. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
j. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.
k. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.
l. Ambient Conditions: Actuator shall be designed for operation from –10 to 150 °F ambient temperature with 0 to 100 percent relative humidity.

2.5 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with ‘two-wire’ type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller shall unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

2.6 TEMPERATURE SENSORS (TS)

A. Sensor range: When matched with A/D converter of BC, AAC/ASC, or Smart Sensor (SS), sensor range shall provide a resolution of no worse than 0.3°F (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

B. Matched Sensors: The following applications shall require matched sensors:

1. Building Loop Connections: Provide matched loop and building supply sensors where control sequence requires controlling to a temperature rise (differential).
2. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants.
3. Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature.

C. Room Temperature Sensor: Shall be a stainless steel wall plate sensor. An electronic thermostat with manual override shall be provided in the office areas and in select common areas as

approved by Owner. Provide ¼" medical grade closed cell foam insulating material. The following sensing elements are acceptable:

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point.

D. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.3°F accuracy at calibration point

E. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.

1. Sensing element shall be platinum RTD, or thermistor, +/- 0.3°F accuracy at calibration point.

F. Liquid immersion temperature sensor shall include thermowell, sensor and connection head for wiring connections. Provide thermally conductive paste in well to ensure good contact with the well. Temperature range shall be as required for resolution of 0.15°F.

1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.15°F.
2. Sensing element (other systems) shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.3°F.

G. Pipe Surface-Mount Temperature Sensor: Sensor are only for use in applications specifically identified on the drawings. Normally only used on condensate return piping for steam systems. Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as required for resolution indicated in paragraph A.

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

H. Outside air sensors shall consist of a sensor, an aspirated enclosure, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as required for resolution indicated in Paragraph A

1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
2. Acceptable Manufacturers: Kele A21 or equal

2.7 TEMPERATURE TRANSMITTERS

A. Where required by Controller, or where wiring runs are over 50 feet, sensors as specified above may be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1°F when applied to the sensor range.

2.8 HUMIDITY TRANSMITTERS

A. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

1. Input Range: 0 to 100% RH.
2. Accuracy (% RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
3. Sensor Operating Range: As required by application
4. Long Term Stability: Less than 1% drift per year.

B. Acceptable Manufacturers: Units shall be Vaisala HM Series, General Eastern, or Honeywell H7 Series.

2.9 PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS (DP)

A. General Purpose - Water: Two-wire transmitter, 4-20 mA output with zero and span adjustments. Plus or minus 0.5% overall accuracy, 450 psig maximum static pressure rating, 200 psid maximum overpressure rating for 6 through 60 psid range, 450 psid for 100 through 300 psid range.

1. Acceptable Manufacturers: Dwyer, Mamac, Setra, or equal.

B. Liquid, Steam and Gas:

1. General: Two-wire smart DP cell type transmitter, 4-20 mA or 1-5 Vdc user-selectable linear or square root output, adjustable span and zero, stainless steel wetted parts.
2. Environmental limits: –40 to 250 °F , 0 to 100% RH..
3. Accuracy: less than 0.1 percent of span.
4. Output Damping: Time constant user selectable from 0 to 36 seconds.
5. Vibration Effect: Less than ±0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
6. Electrical Enclosure: NEMA-4, -4X, -7, -9.
7. Approvals: FM, CSA.
8. Acceptable Manufacturers: Dwyer, Foxboro, Johnson-Yokogawa, Mamac, Setra, or Rosemount Inc.

C. General Purpose Low Pressure Air: Generally for use in static measurement of duct pressure or constant volume air velocity pressure measurement where the range is applicable.

1. General: Loop powered two-wire differential capacitance cell-type transmitter.
2. Output: two wire 4-20 mA output with zero adjustment.
3. Overall Accuracy: Plus or minus 1% of reading.
4. Minimum Range: 0.1 in. w.c.
5. Maximum Range: 10 inches w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Modus T30.
8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
9. Range: Select for specified setpoint to be between 25% and 75% full-scale.

D. General Purpose Low Pressure/Low Differential Air: Generally for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.

1. General: Loop powered, two-wire differential capacitance cell type transmitter.
2. Output: Two-wire 4-20 mA output with zero adjustment.
3. Overall Accuracy: Plus or minus 1% of reading.
4. Minimum Range: 0 in. w.c.
5. Maximum Range: 0.1, 0.25, or 0.5 inches w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Modus T30 or Setra.
8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
9. Range: Select for specified setpoint to be between 25% and 75% full-scale.

E. Velocity Pressure: Generally for use in air velocity pressure measurement where the range is applicable.

1. General: Loop powered two-wire differential capacitance cell type transmitter.
2. Output: Two-wire, 4-20 mA output with zero adjustment.
3. Overall Accuracy: Plus or minus 0.25%
4. Minimum Range: 0 in. w.c.
5. Maximum Range: 1 inch w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Acceptable Manufacturers: Setra 264 with optional FS accuracy above or equal. .
8. Range: Select for minimum range that shall accept the maximum velocity pressure expected.

2.10 VALVE BYPASS FOR DIFFERENTIAL PRESSURE SENSORS

A. Provide a five valve bypass kit for protection of DP sensors where the static on the pipe can cause on over pressure when connected to one port with the other at atmospheric pressure. Kit shall include high and low pressure isolation valves, high and low pressure vent valves, and a bypass valve contained in a NEMA-1 enclosure.

2.11 DIFFERENTIAL PRESSURE SWITCHES (DPS)

A. General Service - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing

B. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0°F to 160°F operating temperature range.

C. Acceptable Manufacturers: BAPI, Dwyer, Honeywell, and Johnson Controls.

2.12 PRESSURE SWITCHES (PS)

A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.

B. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls.

2.13 TRANSDUCERS

A. Standard Capacity Electronic-to-Pneumatic (E-P) Transducers: E-P transducers shall be Voltage-to-Pneumatic (V-P) type, Current-to-Pneumatic (I-P) type,:

1. Electrical Power Supply: 24 Vac or 24 Vdc.
2. Pneumatic Air Supply: 25 psig (1.72 bar) maximum.
3. Air Capacity: 515 scim @ 20 psig (135 cm^3/sec @ 1.38 bar).
4. Air Consumption: Zero at steady state.
5. Output Span: 3-15 psig (.21-1.03 bar).
6. Input: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, or 3-15 Vdc input.
7. Enclosure: Polymer designed for surface or panel mount.
8. Air Connections: ¼" (6.35 mm) barbed.
9. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
10. Acceptable Manufacturers: Kele Model UCP-422.

B. Binary to Analog Transducers or Tri-State-to-Voltage or -Current:

1. Adjustable zero and span.
2. Failure Mode on Power Loss: Shall be provided with memory feature to allow the transducer to return to last value on power failure.
3. Accuracy: ± 1% of span
4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10Vdc, 2-10Vdc, 0-15Vdc, 3-15Vdc
5. Input: 4-20 mA, pulse width modulated or tri-state input.
6. Tri-state Input Time Base: Dip switch selectable.
7. Enclosure: Polymer designed for surface or panel mount.
8. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
9. Acceptable Manufacturers: Kele Model PWA Series.

C. Electronic-to Electronic (Voltage or Current to Current or Voltage):

1. Adjustable zero and span.
2. Failure Mode on Power Loss: Memory feature to allow the transducer to return to last value on power failure.
3. Accuracy: ± 1% of span.
4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, 3-15 Vdc.
5. Input: 0-20 Vdc, 0-20 ma, 0-10 kOhm.
6. Enclosure: Polymer enclosure designed for surface or panel mount.
7. Acceptable Manufacturers: Kele Model PWA Series.

2.14 CURRENT SWITCHES (CS)

A. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)

1. Range: 1.5 to 150 amps.
2. Trip Point: Adjustable.
3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. Lower Frequency Limit: 6 Hz.
5. Trip Indication: LED
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM

8. Acceptable Manufacturers: Veris Industries H-708/908; Inc., Kele SCS1150A-LED.

B. Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150.

1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to a RIBX.

C. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication

1. Range: 1.5 to 135 Amps.
2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. Frequency Range: 5-75 Hz
5. Trip Indication: LED
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM
8. Acceptable Manufacturers: ACI, Functional Devices, or Veris.

D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A).

1. Acceptable Manufacturers: ACI, Functional Devices, or Veris.

E. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

1. Acceptable Manufacturers: ACI, Functional Devices, or Veris.

2.15 CURRENT TRANSFORMERS (CT)

A. Clamp-On Design Current Transformer (for Motor Current Sensing)

1. Range: 1-10 amps minimum, 20-200 amps maximum
2. Trip Point: Adjustable
3. Output: 0-5 VDC.
4. Accuracy: ±0.2% from 20 to 100 Hz.
5. Acceptable Manufacturers: ACI, Functional Devices, or Veris.

2.16 OUTDOOR AIR STATIC PRESSURE SENSING TIP

A. Pressure sensor: Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph. Acceptable manufacturers shall be Dwyer A-306.

B. Low Air Pressure Surge Dampener: 30-second time constant.

C. Acceptable Manufacturers: ACI, Functional Devices, or Veris.

2.17 CONTINUOUS LEVEL TRANSMITTERS

A. Capacitance Type

1. Provide a loop powered, continuous capacitance type level transmitter with adjustable span and zero.
2. Output: 4-20 mA.
3. Probe: Fluoropolymer coated stainless steel rod or cable. Provide cable probe with end attachment hardware or weight.
4. Electrical Enclosure: NEMA-4, -7.
5. Approvals: UL or CSA.
6. Accuracy: ±1% of calibrated span.
7. Process Connection: MPT or ANSI Flange as required.
8. Acceptable Manufacturers: Drexelbrook, Endress & Hauser.

B. Hydrostatic Pressure

1. Two wire smart d/p cell type transmitter
2. 4-20 mA or 1 to 5 volt user selectable linear or square root output
3. Adjustable span and zero
4. Stainless steel wetted parts
5. Environmental limits: –40 to 250 °F (-40 to 121°C), 0 to 100% RH
6. Accuracy: less than 0.1 percent of span
7. Output Damping: time constant user selectable from 0 to 36 seconds
8. Vibration Effect: Less than ±0.1% of upper range limit from 15 to 2000 Hz in any axis relative to pipe mounted process conditions.
9. Electrical Enclosure: NEMA 4, 4X, 7, 9
10. Approvals: FM, CSA
11. Acceptable Manufacturers: Rosemount Inc. 3051 Series, Foxboro, and Johnson-Yokogawa.

2.18 SPECIALTY GAS DETECTION

A. Carbon Dioxide (CO_2) Sensors/Transmitters

1. CO_2 sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.
2. Range: 0-2000 ppm
3. Accuracy: ±36ppm at 800 ppm and 68°F.
4. Stability: 5% over 5 years.
5. Output: 4-20 mA, 0-10 Vdc or relay.
6. Mounting: Duct as indicated
7. Acceptable Manufacturer: Vaisala, Inc. GMD20 (duct) or GMW90 (wall), MSA, Inc, Amphenol sensors.

B. Carbon Monoxide (Co) Detectors

1. The carbon monoxide sensor shall be of maintenance free solid state construction and use a microprocessor based transmitter which calculates various calibration factors and transmits a linear 4 - 20 mA output proportional to carbon monoxide concentration.
2. Wall mounted installations shall be mounted in a NEMA 12 enclosure with field replaceable sensors.

3. Provide a calibration test kit complete with a calibration apparatus, carrying case and test gas cylinder.
4. Provide individual indicators and contactors for each level, initially calibrated for 0 ppm and 100 ppm.
5. Maximum response time to 100 ppm CO calibration gas: Two minutes.
6. Acceptable Manufacturers: MSA Instruments, Honeywell, Critical Environmental Technologies. No exceptions.

2.19 ELECTRIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley.

B. Electric Solenoid-Operated Pneumatic Valves (EP): EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure. Valves shall be ported 2- way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.

1. Coil Enclosure: Indoors shall be NEMA-1, Outdoors and NEMA-3, 4, 7, 9.
2. Fluid Temperature Rating: Valves for compressed air and cold water service shall have 150°F (66°C) minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
3. Acceptable Manufacturers: EP valves shall be as manufactured by ASCO or Parker.
4. Coil Rating: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).

C. Low Temperature Detector (‘Freezestat’) (FZ): Low temperature detector shall consist of a ‘cold spot’ element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20', junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55°F, factory set at 38°F.

D. High Temperature Detectors (‘Firestat’) (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F.

E. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150°F, and a minimum 10°F fixed setpoint differential.

F. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed mercury contacts, operating temperature range of 50 to 90°F, switch rating of 24 Vac (30 Vac max.), and both manual and automatic fan operation in both the heat and cool modes.

G. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.

1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:

a. AC coil pull-in voltage range of +10%, -15% or nominal voltage.
b. Coil sealed volt-amperes (VA) not greater than four (4) VA.
c. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.

d. Pilot light indication of power-to-coil and coil retainer clips.
e. Coil rated for 50 and 60 Hz service.
f. Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA.

2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC.
3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.

H. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1enclosure. Manufacturer shall be Square 'D' or Eaton.

I. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. Transformer shall be proper size for application, and mounted in minimum NEMA-1 enclosure.

1. Transformers shall be manufactured by Eaton, Square ‘D’, or Jefferson.

J. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.

1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
2. TDRs shall be UL and CSA listed, Crouzet type.

K. Electric Push Button Switch:

1. Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley.
2. Critical Room, Type-I: An emergency operator station shall offer a highly visible method to shut down equipment, initiate alarms, or give a controller input during emergency conditions. Dedicated name plate shall clearly identify the system (e.g. Emergency Boiler Shut-Down). Operation is with the push of a red 40 mm mushroom-head push-button. The button may be reset with a pull or twist of the mushroom head, depending on the button style. Acceptable manufacturer: Kele “ESM” or equal.
3. Critical Room, Type-II: An emergency operator station that is exposed to public access shall conform to Type-I with a break glass function. Acceptable manufacturer: Kele “ESB” or equal.

L. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley.

M. Audible & Visual Alarm:

1. Panel: Panel-Face mounted audible & LED visual alarm shall be a continuous tone. Acceptable manufacturer: Mallory “Sonalert” or equal.
2. Remote Station: Wall-mounted audible & LED visual alarm on a stainless steel plate. Any contact closure alarm initiating device that can switch 24 VAC or DC can be used. When 24 VAC or DC is applied, through an alarm initiating device, the red alarm LED shall light, the horn shall sound and the alarm status relay will energize. Acceptable manufacturer: Kele “RAD-1” or equal.

3. Critical Room: Wall-mounted or panel-mounted 24VAC, 24VDC, OR 12VAC strobe (amber) and horns shall be provided as shown on design sheets. Audible alarm shall be at 90 dba @ 10-feet, minimum. Acceptable manufacturer: Edwards Signaling “868STR” or equal.

N. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley.

2.20 DUCT SMOKE DETECTOR

A. Photoelectric detector with sampling tube that spans the entire width of duct. .

B. Velocity Rating: 100 to 4000 fpm or 500 to 4000fpm depending on the minimum velocity in the duct. Provide the 100 to 4000 fpm detector if the min duct velocity is below 550 fpm.

C. Output Contact: Alarm, two sets form “C” rated at 10amps 115V resistive. One set of alarm contacts for BAS monitoring and fan shutdown. Trouble, one set of contacts.

D. Temperature & RH limits: 32 to 120°F and 10 to 85% relative humidity.

E. Acceptable Manufacturer:

1. Sensor Systems D4120
2. Air Products and Controls SL-2000

2.21 NAMEPLATES

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

2.22 TESTING EQUIPMENT

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/- 0.25% accurate over same range).

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.2 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.

B. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. Wiring System: Install complete wiring system for electric control systems. Install all control wiring external to panels in electric metallic tubing or raceway. On Renovation projects, wiring in finished areas shall be routed in wire mold. The routing of wiring in finished areas must be specifically approved by the AOR/EOR. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 26 of the contract documents. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
2. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 26 of the contract documents.
3. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
4. All WAN and LAN Communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN Communication wiring shall be labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals. All WAN and LAN cabling shall comply with applicable Division 26 requirements.
5. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings.

C. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down.

D. Freezestats: Install freezestats in a serpentine fashion where shown on drawing. Provide one foot of element for each square foot of coil face area. The length of element not just down- stream of the coil shall not be included in the coverage calculation. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application, wired in series for normally closed, open on trip application. Adequately support with coil clips such that sensor is not in direct contact with equipment. Coordinate the location of the switch such that it is normally accessible.

E. Room Temperature Sensors: Install sensors as shown on the drawings. Provide approved security screws for mounting, matching those installed in other areas of the project. Provide 3 tools to the Owner for installation and removal of the security screws. Seal conduit penetrations at the wall box airtight. Install batt insulation in the wall box to completely fill the box. Electrical connections shall be made using a twist-on sealant filled connectors suitable for the installation.

F. Averaging Temperature Sensors: Cover no more than three square feet per linear foot of sensor length except where indicated. Generally, the sensor shall be located where flow is sufficiently homogeneous/adequately mixed, consult AE for requirements.

G. Airflow Measuring Stations: Install per manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFM station manufacturer.

H. Fluid Flow Sensors: Install per manufacturer's recommendations in an unobstructed straight length of pipe.

I. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.

J. Differential Pressure Transmitters: Provide valve bypass arrangement to protect against over pressure damaging the transmitter.

K. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.

L. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.

M. Supply Duct Pressure Transmitters:

1. General: Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.
2. VAV System 'Down-Duct' Transmitters: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system.

N. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.

END OF SECTION

SECTION 23 09 22

BUILDING AUTOMATION SYSTEM (BAS) - FIELD PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Building Controllers (BC).
2. Application Specific Controllers (ASC).
3. Advanced Application Controllers (AAC).

1.2 DESCRIPTION OF WORK

A. Furnish and install DDC Control units and/or Smart Devices required to support specified building automation system functions.

B. Refer to Division 23 Section “Building Automation System (BAS)” for general requirements.

C. Warranty Period: Refer to specification 23 09 20, section 1.13 for Warranty requirements.

PART 2 - PRODUCTS

2.1 STAND-ALONE FUNCTIONALITY

A. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category specified in PART 3. This item refers to acceptable paradigms for associating the points with the processor.

B. Functional Boundary: Provide controllers so that all points associated with and common to one unit or other complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the contract documents. Generally systems specified for the Application Category shall dictate the boundary of the standalone control functionality. See related restrictions below. When referring to the controller as pertains to the standalone functionality, reference is specifically made to the processor. One processor shall execute all the related I/O control logic via one operating system that uses a common programming and configuration tool.

C. The following configurations are considered acceptable with reference to a controller’s standalone functionality:

1. Points packaged as integral to the controller such that the point configuration is listed as an essential piece of information for ordering the controller (having a unique ordering number).
2. Controllers with processors and modular back planes that allow plug in point modules as an integral part of the controller.

3. I/O point expander boards, plugged directly into the main controller board to expand the point capacity of the controller.
4. I/O point expansion devices connected to the main controller board via wiring and as such shall be remote from the controller and that communicate via a sub LAN protocol. These arrangements to be considered standalone shall have a sub LAN that is dedicated to that controller and include no other controller devices. All wiring to interconnect the I/O expander board shall be:

    a. Contained in the control panel enclosure;
    b. Or run in conduit. Wiring shall only be accessible at the terminations.

5. General purpose I/O or Smart Devices racked with a processor module in the same contiguous physical enclosure. The controller shall also include its own dedicated processor module and bridge or router making the controllers LAN communication a subnet or LAN segment dedicated to that controller as specified under Application Categories below. The following are additional requirements of this configuration:

    a. Configuration must meet the requirements for battery back up.
    b. If processor fails, the I/O devices shall go to their fail condition.
    c. Contractor shall provide a network bandwidth analysis of the controller segment or subnet. The analysis shall document network bandwidth utilization does not exceed 30% for a continuous one hour period.
    d. Logic must provide for orderly sequencing of I/O during a power interruption and restart of program logic upon restoration of power.
    e. Programming must facilitate a robust uploading scheme and limit available bandwidth during upload.
    f. Trending shall be buffered in the processor or dedicated data logging module and uploaded to a Building or Network Controller.

2.2 BUILDING CONTROLLER (BC)

A. General Requirements:

1. The BC(s) shall provide fully distributed control independent of the operational status of the OWSs and CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device.
2. BCs shall be connected to a controller network that qualifies as a Primary Controlling LAN. BCs shall share information with the entire network of BCs and AACs/ASCs for full global control.
3. BCs shall be programmable from an operator workstation, portable operator's terminal, or hand held operating device. Each controller shall permit multi-user operation from multiple owner interfaces connected either locally or over the Primary Controller LAN.
4. All control strategies performed by the BCs shall be both operator definable and modifiable through the Operator Interfaces. All point data, algorithms and application software within each BC shall be modifiable from the Operator Workstation.
5. Each BC shall be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices.
6. BCs shall perform overall system coordination, accept control programs, perform automated HVAC functions, control peripheral devices and perform all necessary mathematical and logical functions.

7. Each unit shall have its own internal RAM, non-volatile memory, microprocessor, battery backup, regulated power supply, power conditioning equipment, ports for connection of operating interface devices, and control enclosure.
8. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.
9. All BCs shall be protected from any memory loss due to a loss of power by one or a combination of the following:

    a. Volatile RAM shall have a battery backup using a lithium battery with a rated service life of fifty (50) hours, and a rated shelf life of at least five years. Self- diagnostic routine shall report an alarm for a low battery condition.
    b. EEPROM, EPROM, or NOVROM non-volatile memory

10. Each BC shall provide for point mix flexibility and expandability. This requirement shall be met via either a family of expander boards, modular input/output configuration, or a combination thereof.
11. Each BC shall execute application programs, calculations, and commands via a microprocessor resident in the BC.
12. The database and all application programs for each BC shall be stored in non-volatile or battery backed volatile memory within the BC and shall be able to upload/download to/from the OWS and/or CSS.
13. BCs shall provide buffer for holding alarms, messages, trends etc.
14. Each BC shall include self-test diagnostics, which allow the BC to automatically alarm any malfunctions, or alarm conditions that exceed desired parameters as determined by programming input.
15. Each BC shall contain software to perform full DDC/PID control loops.
16. For systems requiring end-of-line resistors those resistors shall be located in the BC, if it has I/O capability.
17. Input-Output Processing

    a. Digital Outputs (DO): Outputs shall be rated for a minimum 24 Vac or Vdc, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and Each DO shall be discrete outputs from the BC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
    b. Analog Inputs (AI): AI shall be O-5 Vdc, 0-10 Vdc, 0-20 Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 12 bits.
    c. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors shall only be done in non-critical applications and only with prior approval of Architect/Engineer.
    d. Universal Inputs (UI-AI or DI): To serve as either AI or DI as specified above.
    e. Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection.
    f. Pulse Width Modulated (PWM) analog via a DO and transducer are not acceptable.

g. Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the BC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.
h. Pulsed Inputs: Capable of counting up to 8 pulses per second with buffer to accumulate pulse count. Pulses shall be counted at all times.

18. A communication port for operator interface through a terminal shall be provided in each BC. It shall be possible to perform all program and database back-up, system monitoring, control functions, and BC diagnostics through this port. Standalone BC panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or workstations.
19. Each BC shall be equipped with loop tuning algorithm for precise proportional, integral, derivative (PID) control. Loop tuning tools provided with the Operator Workstation software is acceptable. In any case, tools to support loop tuning must be provided such that P, I, and D gains are automatically calculated.
20. Slope intercepts and gain adjustments shall be available on a per-point basis.
21. BC Power Loss:

a. Upon a loss of power to any BC, the other units on the primary controlling network shall not in any way be affected.
b. Upon a loss of power to any BC, the battery backup shall ensure that the energy management control software, the Direct Digital Control software, the database parameters, and all other programs and data stored in the RAM are retained for a minimum of fifty (50) hours.
c. Upon restoration of power within the specified battery backup period, the BC shall resume full operation without operator intervention. The BC shall automatically reset its clock such that proper operation of any time dependent function is possible without manual reset of the clock. All monitored functions shall be updated.
d. Should the duration of a loss of power exceed the specified battery back-up period or BC panel memory be lost for any reason, the panel shall automatically report the condition (upon resumption of power) and be capable of receiving a download via the network, and connected computer. In addition, the owner shall be able to upload the most current versions of all energy management control programs, Direct Digital Control programs, database parameters, and all other data and programs in the memory of each BC to the operator workstation via the local area network, or via the telephone line dial-up modem where applicable, or to the laptop PC via the local RS-232C port.

22. BC Failure:

a. Building Controller LAN Data Transmission Failure: BC shall continue to operate in stand-alone mode. BC shall store loss of communication alarm along with the time of the event. All control functions shall continue with the global values programmable to either last value or a specified value. Peer BCs shall recognize the loss, report alarm and reconfigure the LAN.
b. BC Hardware Failure: BC shall cease operation and terminate communication with other devices.

23. Each BC shall be equipped with firmware resident self-diagnostics for sensors and be capable of assessing an open or shorted sensor circuit and taking an appropriate control action (close valve, damper, etc.).
24. BCs shall include LAN communications interface functions for controlling secondary controlling LANs Refer to Division 23 Section " Building Automation System (BAS) - Communications Devices" for requirements if this function is packaged with the BC.
25. A minimum of four levels of password protection shall be provided at each BC.
26. BCs shall be mounted on equipment, in packaged equipment enclosures, or locking wall mounted in a NEMA 1 enclosure.

B. BACnet Building Controller (B-BC) Requirements:

1. The BC(s) shall support all BIBBs defined in the BACnet Building Controller (B-BC) device profile as defined in the BACnet standard.
2. BCs shall communicate over the BACnet Building Controller LAN.
3. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.
4. Provide routers and repeaters as required to combine different BACnet IP networks onto the primary Ethernet/IP network, or as required to segment groups of BACnet devices to meet minimum throughput requirements.
5. Provide all necessary bridge or routers and gateways in order to connect BCs to the primary network, and subsequently, connect to the BAS WAN network.
6. Device to device communication shall be event driven and peer to peer.
7. Propagation of data from a PCU to a Router for the execution of supervisory control logic shall be event driven at the device and not based on polling from the Router.
8. Propagation of data from a PCU to a Router to support non-alarm dynamic data display or for trending purposes shall be based on polling from the Router.
9. Propagation of data from a PCU to a Router to support the reporting of alarm conditions shall be event driven at the device and not based on polling from the Router.
10. The programming of all output network variables shall include the send on delta concept; minimum send time and maximum send time parameters.

    a. Send on delta parameters shall be non-zero values selected to ensure efficient use of the available bandwidth but not exceeding the following:
        1) Temperatures: 0.30 Degrees Fahrenheit
        2) Pressures in Air Systems: 0.025 Inches-of-Water
        3) Building Static Pressure: 0.0125 Inches-of-Water
        4) Flow: Approximately 10 Cfm or 2% of the system operating range
        5) Relative Humidity: 3%
        6) Analog Position: 2%
        7) Enthalpy: Approximately 0.2 Btu per Lb.
        8) Binary Alarm Data: Change of State

    b. If the minimum send time parameters can be set on a point by point basis, they shall not exceed the following:
        9) Alarms: 1 second

10) Temperatures at Zone Level: 60 seconds

11) Temperatures at Central Station Level: 10 seconds for data reporting, 5 seconds for control purposes

12) Pressures: 5 seconds for data reporting, 1 second for control purposes.

c. If the minimum send time parameters can only be set on a controller basis, set the parameter at a value of 5 seconds.

11. The error rate for each channel shall be verified by a one hour test using the network analysis tool. The error rate shall not exceed 1%.
12. The bandwidth utilization for each channel shall be verified by a one hour test using the network analysis tool. The utilization shall not exceed 30%.
13. All products shall be BACnet certified, and shall be designed according to the BACnet Interoperability Guidelines. Product documentation and devices shall display the BACnet symbol, indicating conformance to the BACnet Testing Laboratory (BTL) Standards.
14. In those instances in which BACnet devices are not available, the Network Integrator (BAS Contractor) shall provide one of the following:

a. Provide BACnet devices with application source code, device resource files, and external interface definitions.
b. Provide software licenses and tools required to integrate and commission for non-BACnet devices. Coordinate and work with equipment start-up personnel to successfully integrate non-BACnet devices to a BC.

2.3 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)

A. General Requirements:

1. AACs and ASCs shall provide intelligent, standalone control of HVAC equipment.
2. Each unit shall have its own internal RAM, non-volatile memory and shall continue to operate all local control functions in the event of a loss of communications on the ASC LAN or sub-LAN.
3. Refer to standalone requirements by application specified in PART 3 of this Section.
4. In addition, it shall be able to share information with every other BC and AAC /ASC on the entire network.
5. Each AAC and ASC shall include self-test diagnostics that allow the AAC /ASC to automatically relay to the BC, LAN Interface Device or workstation, any malfunctions or abnormal conditions within the AAC /ASC or alarm conditions of inputs that exceed desired parameters as determined by programming input.
6. AACs and ASCs shall include sufficient memory to perform the specific control functions required for its application and to communicate with other devices.
7. Each AAC and ASC must be capable of stand-alone direct digital operation utilizing its own processor, non-volatile memory, input/output, minimum 8 bit A to D conversion, voltage transient and lightning protection devices. All volatile memory shall have a battery backup of at least fifty- (50) hrs with a battery life of five years.
8. All point data; algorithms and application software within an AAC /ASC shall be modifiable from the Operator Workstation.
9. AAC and ASC Input-Output Processing

a. Analog Inputs (AI): AI shall be 0-5 Vdc, 0-10Vdc, 0-20Vdc, and 0-20 mA. Provide signal conditioning, and zero and span calibration for each input. Each input shall be a discrete input to the BC's board (multiplexing to a separate manufacturers board is unacceptable unless specifically indicated otherwise). A/D converters shall have a minimum resolution of 8-10 bits depending on application.
b. Digital Inputs (DI): Monitor dry contact closures. Accept pulsed inputs of at least one per second. Source voltage for sensing shall be supplied by the BC and shall be isolated from the main board. Software multiplexing of an AI and resistors shall only be done in non-critical applications and only with prior approval of Architect/Engineer
c. Universal Inputs (UI): To serve as either AI or DI as specified above.
d. Electronic Analog Outputs (AO): Voltage mode: 0-5 Vdc and 0-10 Vdc; Current mode: 4-20 mA. Provide zero and span calibration and circuit protection.
e. Pulse Width Modulated (PWM) analog via a DO and transducer are not acceptable.
f. Digital Outputs (DO): Outputs shall be rated for a minimum 24 VAC or VDC, 1 amp maximum current. Each shall be configurable as normally open or normally closed. Each output shall have an LED to indicate the operating mode of the output and Each DO shall be discrete outputs from the AAC/ASC's board (multiplexing to a separate manufacturer's board is unacceptable). Provide suppression to limit transients to acceptable levels.
g. Universal Outputs (UO): To serve as either AO or DO as specified above.
h. Analog Output Pneumatic (AOP), 0-20 psi: Pneumatic outputs via an I/P transducer, or digital to pneumatic transducer are acceptable. Multiplexed digital to pneumatic transducers are acceptable provided they are supplied as a standard product and part of the AAC /ASC and provide individual feedback. Multiplexed pneumatic outputs of a separate manufacturer are unacceptable.

B. BACnet AAC(s) and ASC(s) Requirements:

1. The AAC(s) and ASC(s) shall support all BIBBs defined in the BACnet Building Controller (B-AAC and B-ASC) device profile as defined in the BACnet standard.
2. Each AAC shall communicate over the BACnet Building Controller LAN.
3. Each ASC shall communicate over the BACnet Building Controller LAN or AAC sub-LAN.
4. Each BC shall be connected to the BACnet Building Controller LAN communicating to/from other BCs.

C. Terminal Box Controllers:

1. Terminal box controllers controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded. The software shall select scheduled boxes randomly and shall not allow more than 5% of the total quantity of controllers in a building to perform this function at the same time. When possible the controllers shall perform this function when the supply or exhaust air system is not operating or is unoccupied.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Contractor.

3.2 SYSTEM ACCESS:

A. Provide an Ethernet connection and 5 port hub at each panel housing a controller or controllers that provides access to the Local Supervisory LAN and to the Control System Server for all Controllers, other than an Application Category 1 Controllers. The user shall be able to access each controller on the system using this connection via the Control System Server database for graphics, schedules, programming, controller configuration etc.

3.3 INSTALLATION OF CONTROL SYSTEMS:

A. General: Install systems and materials in accordance with manufacturer's instructions, contract documents, roughing-in drawings, and details shown on drawings. Contractor shall install all controllers in accordance with manufacturer’s installation procedures and practices.

3.4 HARDWARE APPLICATION REQUIREMENTS

A. Here is where you assert your concept of optimal mix of power/quality/cost effectiveness. There are multiple levels of controller/application defined, the higher Category numbers being more powerful and expensive. The AE defines - within each category - what system(s) must be controlled (in standalone fashion) by controllers that meet that category. This item needs specific attention on every project.

B. General: The functional intent of this specification is to allow cost effective application of manufacturers standard products while maintain the integrity and reliability of the control functions. Specific requirements indicated below are required for the respective application. Manufacturer shall apply the most cost-effective unit that meets the requirement of that application.

C. Standalone Capability: Each Control Unit shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU with only the exceptions enumerated below. Refer to Item 2.01 above for physical limitations of standalone functionality. Listed below are functional point data and calculated values that shall be allowed to be obtained from or stored by other CUs or SDs via LAN.

D. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.

E. Application Category Type 0 (Distributed monitoring)

1. Applications in this category include the following:

a. Monitoring of variables that are not used in a control loop, sequence logic, or safety.

2. Points on BCs, AACs, and ASCs may be used in these applications as well as Ds and/or general-purpose I/O modules.
3. Where these points are trended, contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.
4. LAN Restrictions: These points may reside on any controller

F. Application Category Type-1:

1. Applications in this category include the following:

a. Airflow Control Boxes (VAV Terminal Units)
b. Terminal Control Dampers/Reheat Valves
c. Unitary equipment <15 tons (Package Terminal AC Units, Split-System AC Units)

2. Standalone Capability: Provide capability to execute control functions for the application for a given setpoint or mode, which shall generally be occupied mode control. Only the following data (as applicable) may be acquired from other controllers via LANs. In the event of a loss of communications with any other controller, or any fault in any system hardware that interrupts the acquisition of any of these values, the ASC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Value
Scheduling Period	Normal _____
Morning Warm-Up	Off (cold discharge air)
Load Shed	Off (no shedding)
Summer/Winter	Winter
Trend Data	N/A

3. Mounting:

a. ASCs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
b. ASCs that control equipment mounted in a mechanical room shall either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
c. ASCs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.
d. Contractor for this Section may furnish ASCs to the terminal unit manufacturer for factory mounting.

4. LAN Segment Restrictions:

a. BACnet Systems: Limit the number of AAC's/ASC's servicing any one of these applications on the LAN Segment to 32. VAV terminals or zone dampers/reheat coils served by a single air handler are to be located on the same segment of the LAN with the AHU. Multiple AHU's may reside on a LAN segment if all the

associated/served terminal boxes and zone dampers/reheat coils are located on the same LAN segment. If more than 40 VAV terminals or zone dampers/reheat coils are served by a single air handler, then one LAN segment shall be fully populated with the parent air handler and terminal unit Nodes with the balance of the served terminal units Nodes located on the secondary channel located on the same BC controller.

G. Application Category Type 2

1. Applications in this category include the following:

   a. Unitary Equipment (Air Conditioners, packaged Heating/Cooling Units, and the like)
   b. Constant Volume Pump (Start/Stop or Status)
   c. Misc. Equipment (Exhaust Fan) Start/Stop
   d. Misc. Monitoring (not directly associated with a control sequence and where trending is not critical)
   e. Variable Speed Drive (VSD) controllers not requiring safety shutdowns of the controlled device

2. Standalone Capability: Only the following data (as applicable) may be acquired from other AACs via LANs. In the event of a loss of communications with any other AACs, or any fault in any system hardware that interrupts the acquisition of any of these values, the AAC shall use the last value obtained before the fault occurred. If such fault has not been corrected after the specified default delay time, specified default value(s) shall then be substituted until such fault has been corrected.

Physical/Virtual Point	Default Delay Time	Default Value	
Outside Air Temperature	3 minutes	80°F	
Outside Air Humidity	3 minutes	60%RH	
Outside Air Enthalpy	3 minutes	30 Btu/lb	
Trend Data		N/A	
Cooling/Heating Requests		3 minutes	none

3. Mounting:

   a. AACs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure and shall be rated for plenum use.
   b. AACs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
   c. AACs that control equipment mounted outside or in occupied spaces shall either be located in the unit or in a proximate mechanical/utility space.

4. LAN Segment Restrictions:

   a. BACnet Systems: Limit the number of AAC's servicing any one of these applications on the LAN Segment to 32.

H. Application Category Type 3

1. Applications in this category include the following:

a. Boiler Factory Integrated Control (unit specific)
b. Central Heating Plant
c. Sequenced or Variable Speed Pump Control
d. Air Handlers (greater than 25 tons)

2. LAN Segment Restrictions:

a. BACnet Systems: BCs shall be used in these applications.

3.5 CONTROL UNIT REQUIREMENTS

A. Refer to Division 23 Section "Building Automation System (BAS)" for requirements pertaining to control unit quantity and location.

END OF SECTION

SECTION 23 09 23

BUILDING AUTOMATION SYSTEM (BAS) – NETWORK, SOFTWARE/PROGRAMMING, AND INTEFACE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes network integration devices.

B. Section includes owner interface devices. Includes the following:

1. Control System Server (CSS).
2. Operator Workstation (OWS).
3. Portable Operator Terminal (POT).
4. Panel LCD or Touchscreen Displays (TCP_D)
5. Printers.

C. Section includes Software & Programming. Includes the following:

1. System Software.
2. Programming Description.
3. Control Algorithms.
4. Energy Management Applications.
5. Password Protection.
6. Alarm Reporting.
7. Trending.
8. Data Acquisition and Storage.
9. Point Structuring.
10. Dynamic Color Graphics.

1.2 DESCRIPTION OF WORK:

A. Communication Devices:

1. Contractor shall provide all interface devices and software to provide an integrated system connecting Advanced Application Controllers, Application Specific Controllers, Building Controllers, Gateways, and Control System Server.
2. The Control System Server shall be the only equipment connected to the Owner's secured WAN.

B. Owner Interfaces:

1. Furnish and install all Operator Interfaces and Control System Servers for the BAS functions specified. All computers shall be warranted by the manufacturer for a period as stated in 230920 after final acceptance. CSS computers shall also be Dell computers.
2. Local BAS Workstation: The new BAS system shall be web accessible through a internet browser.

C. Software and Programming:

1. Fully configure systems and furnish and install all software, programming and dynamic color graphics for a complete and fully functioning system as specified.

D. Refer to entirety of Division 23 Section "Building Automation System (BAS)" for all requirements.

E. Warranty Period: Refer to specification 23 09 20, section 1.13 for Warranty requirements.

1.3 LICENSING

A. Include licensing for all software packages at all required Control System Server (CSS) Operator Work Stations (OWS), and/or Portable Operator Terminal (POT).

B. Any operator interface, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be fully licensed (non-subscription) and fully provided to the Owner.

C. Include licensing for all software packages at all required Web Server, OWS's, and/or POT's. Licensing shall allow access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing; no exception. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be fully licensed (non-subscription) and provided to the Owner.

D. All software should be available on all Web Servers and OWS's provided, and/or on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least 2 sets of CDs (or flash drives) shall be provided with backup software for all software provided, so that the Owner may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses. These backup shall include a backup of all program data files, graphics etc. and shall allow the owner to completely restore the system in the case of a computer malfunction.

E. Provide evidence of licensing including version and original software copies for each WEB Server OWS's and POT's. Licenses shall allow for access to any site device and shall not be restricted to accessing, database management, configuring, etc. the LANs included in this project. The licensing and registration proof shall be provided when the system is installed on site.

F. Upgrade all software packages to the release (version) in effect at the end of the Warranty Period and provide a letter indicating the current release/version date at the end of the warranty period.

PART 2 - PRODUCTS

2.1 NETWORK CONNECTION

A. The Owner's WAN:

1. Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.
2. Only one (1) IP address shall be provided by the owner. This Contractor shall coordinate and comply with the owner's technology group's requirements.
3. This Contractor shall provide and configure an independent BAS network.

2.2 BACNET: BUILDING CONTROLLER (BC)

A. The BC shall be a microprocessor-based communications device which acts as a router between the Primary LAN and Supervisory LAN.

B. The BC shall perform information translation between the Primary LAN and the Supervisory LAN, supervise communications on a polling supervisory LAN, and shall be applicable to systems in which the same functionality is not provided in the BC.

C. BC shall support interrogation, full control, and all utilities associated with all AACs and ASCs under the Primary Controller LAN.

D. All BACnet Interoperability Building Blocks (BIBBs) are required to be supported for each native BACnet device.

2.3 INTEGRATION:

A. Modbus Node:

1. Modbus shall be utilized for Automatic Transfer Switches and/or Generators.
2. Modbus shall be utilized for Utility & Sub Meters.
3. Modbus shall be integrated to a BC level controller. No exception.

2.4 CONTROL SYSTEM SERVER (CSS) TO PROVIDE SECURED-DISTRIBUTED ACCESSIBILITY.

A. The BAS contractor shall provide their latest server specification requirements to the owner BAS Manager to assure the BAS network, software, and graphical capacities are met. Failure to provide such coordination shall require the BAS contractor to provide upgrades at no cost to the design team and owner.

B. Provide software registration cards and/or licenses to the Owner for all included software.

C. Provide network configuration tool, all programming applications, graphic creation tools and all other software required to configure and operate the system.

D. Provide all controller configuration and interface software and/or plug in's for all devices applicable. All shall be loaded and functional. Provide all required interface cables required to connect to all networks, routers, controllers, SDs etc.

E. Provide all enterprise software, licenses, cables, peripherals etc. for a complete system. Software and licenses shall unify all BC controllers on the Primary LAN to display a single GUI interface.

F. The CSS web server shall support browser access via latest version of Google, Microsoft Internet Explorer (11.0 or higher) or Mozilla Firefox.

G. The server shall have two (2), LAN network cards compatible with the Owner's WAN and BAS LAN systems or as shown on the BAS control riser diagram.

H. The server computer shall not function as the workstation. The web server shall provide the link between the owner's WAN and the site specific BAS LAN.

I. All information exchanged over Internet shall be optionally encrypted and secure via Secure Sockets Layer (SSL).

J. The system shall be able to generate e-mails automatically for alarming using a "MS Outlook" or similar platform that meets the requirements of the Owner's as published in the "Minimum Hardware, Software, and Network Standards".

K. The web server licensing options shall allow concurrent access by an unlimited number of browser connections.

L. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Google Chrome™, Internet Explorer™ or Netscape Navigator™. Systems

requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable. For example, a webserver that requires a Java script to load would not be acceptable nor would the use of an alternate to a webserver such as Microsoft Terminal Services.

M. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS shall not be acceptable.

N. The Web server shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

O. For CSSs that provide web services for presentation of data across the Internet, all Web components and services shall be installed with required licensing. CSS shall be configured to secure it to the extent practical inside the Local Supervisory LAN.

P. CSS shall always function from behind a firewall provided either by the Owner's network administrators in the case where they provide the LAN infrastructure, or by this contractor where the LAN is provided under this Division of the specifications.

Q. The CSS shall be placed as indicated on the drawings or as directed by the Owner.

2.5 OPERATOR WORKSTATION (OWS) TO PROVIDE SITE-SPECIFIC ACCESSIBILITY.

A. The BAS contractor shall provide their latest workstation specification requirements to the owner's BAS Manager to assure the BAS network, software, and graphical capacities are met. Failure to provide such coordination shall require the BAS contractor to provide upgrades at no cost to the design team and owner.

B. Provide software registration cards and/or licenses to the Owner for all included software.

C. Provide network configuration tool, all programming applications, graphic creation tools and all other software required to configure and operate the system.

D. Provide all controller configuration and interface software and/or plug in's for all devices applicable. All shall be loaded and functional. Provide all required interface cables required to connect to all networks, routers, controllers, SDs etc.

E. Operating system for operator workstation shall be Microsoft Windows 8.1 Pro with Office 2013 or greater. All software shall be at least the latest version available as of the date of contract completion.

F. Provide network card specifications to the owner approved by the BAS manufacturer to support Supervisory LAN communications (100 Mbps Ethernet TCP/IP).

2.6 OPERATOR INTERFACE:

A. Local Server Hardware:

1. The CSS web server shall support browser access via latest version of Microsoft Internet Explorer (11.0 or higher), Mozilla Firefox, or Google Chrome.
2. The server shall have two (2), LAN network cards compatible with the Owner's WAN and BAS LAN systems or as shown on the BAS control riser diagram.

3. The server computer shall not function as the workstation. The web server shall provide the link between the Owner's WAN and BAS LAN.
4. All information exchanged over Internet shall be optionally encrypted and secure via Secure Sockets Layer (SSL).
5. The system shall be able to generate e-mails automatically for alarming using a "MS Outlook" or similar platform that meets the requirements of the Owner's as published in the "Minimum Hardware, Software, and Network Standards".
6. The web server licensing options shall allow concurrent access by an unlimited number of browser connections.
7. Provide software registration cards to the Owner for all included software.
8. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Google Chrome™, Internet Explorer™ or approved equal. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable. For example, a webserver that requires a Java script to load would not be acceptable nor would the use of an alternate to a webserver such as Microsoft Terminal Services.
9. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS shall not be acceptable.
10. The Web server shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
11. Provide all enterprise software, licenses, cables, peripherals etc. for a complete system. Software and licenses shall unify all BC controllers on the Primary LAN to display a single GUI interface.
12. Provide network configuration tool, all programming applications, graphic creation tools and all other software required to configure and operate the system.
13. For CSSs that provide web services for presentation of data across the Internet, all Web components and services shall be installed with required licensing. CSS shall be configured to secure it to the extent practical inside the Local Supervisory LAN.
14. CSS shall always function from behind a firewall provided either by the Owner's network administrators in the case where they provide the LAN infrastructure, or by this contractor where the LAN is provided under this Division of the specifications.
15. Provide network card approved by BAS manufacturer to support Supervisory LAN communications (100 Mbps Ethernet TCP/IP).
16. Provide an uninterruptible power supply system providing battery backup for the operator workstation and peripheral devices, excluding the printer. UPS shall protect against blackouts, brownouts, surges and noise. UPS shall include LAN port and modem line surge protection. UPS shall be sized for a 4-minute full load runtime, 12-minute ½ load runtime, with a typical runtime of up to 30 minutes. Transfer time shall be 2-4 milliseconds. UPS shall provide a 480-joule suppression rating and current suppression protection for 36,000 amps and provide 90% recharge capability in 2-4 hours. Suppression response time shall be instantaneous. UPS low voltage switching shall occur when supply voltage is less than 94 volts. UPS shall be provided with phone and data surge suppression and LAN port connections. Provide all software, cables, peripherals etc. for a complete system including software to automatically shut-down the computer. Basis-of-Design: Functional Device, PSH600-UPS.

17. Provide a workstation locking cable and lock. Secure workstation onto the desk it shall reside on.
18. The CSS shall be placed as indicated on the drawings or as directed by the Owner.
19. The CSS shall meet or exceed the requirements for the OWS hardware.
20. Warranty: See specification section 23 09 20, section 1.13.
21. Basis-of-Design: Dell Precision 7920 Rack Series.

B. Local Workstation Hardware:

1. Provide one (1) desktop PC workstation for permanent on-site access to the BAS System.
2. Provide software registration cards to the Owner for all included software.
3. Local Workstation Operators Terminal shall support system management by connection to the controllers, by connection via the Internet, and by dial-up communications while serving as the remote workstation.
4. The workstation shall meet the following minimum requirements:
5. Processor: Intel Core i7-8700HQ Quad Core Processor (12M cache, up to 4.6GHz)
6. Operating System: Windows 10 Professional
7. Memory: 16GB 2666 MHz, DDR4, 64GB
8. Hard Drive: 1TB, 7200 rpm
9. Video Card: NVIDIA GeForce GTX1050Ti with 4GB GDDR5 graphics memory
10. Optical Drive: DVD-RW Drive
11. Ports: (1) HDMI, (1) VGA, (1) SD Reader, (2) USB-C, (4) USB 3.1, (2) USB 2.0, (1) GB Ethernet, (1) Display Port, (1) lock security slot
12. Keyboard: Logitech™ detachable keyboard with standard typewriter layout, function keys, and separate numeric keypad.
13. Mouse: Logitech™ Dark-Field™ Anywhere Mouse.
14. Microsoft Office: Include
15. Security Software: McAfee LiveSafe Subscription
16. Security Hardware:Include cable and lock
17. ENERGYSTAR: Required.
18. EPEAT Qualified: Required.
19. Monitor Requirements:

    a. Size: LG™ Widescreen 29” or equal.
    b. Ports: (2) HDMI, (1) Display Port and DVI-D Port.
    c. Resolution: 2560 x 1080. LED.

20. Workstation PC shall have the capability of changing serial port interrupt vectors and IOBASE addresses through software.
21. Provide an uninterruptible power supply system providing battery backup for the operator workstation and peripheral devices, excluding the printer. UPS shall protect against blackouts, brownouts, surges and noise. UPS shall include LAN port and modem line surge protection. UPS shall be sized for a 4-minute full load runtime, 12-minute ½ load runtime, with a typical runtime of up to 30 minutes. Transfer time shall be 2-4 milliseconds. UPS shall provide a 480-joule suppression rating and current suppression protection for 36,000 amps and provide 90% recharge capability in 2-4 hours. Suppression response time shall be instantaneous. UPS low voltage switching shall occur when supply voltage is less than 94 volts. UPS shall be provided with phone and data surge suppression and LAN port connections. Provide all software, cables, peripherals

etc. for a complete system including software to automatically shut-down the computer. Basis-of-Design: Functional Device, PSH600-UPS.

22. Provide network configuration tool, all programming applications, graphic creation tools and all other software required to configure and operate the system.
23. Provide additional hardware, video drivers, etc., to facilitate all control functions and software requirements specified for the BAS.
24. OWS shall be placed as indicated on the drawings or as directed by the Owner.
25. Warranty: See specification section 23 09 20, section 1.13.
26. Basis-of-Design: Dell Precision 7820 Tower Series.

C. Printer:

1. Function: Print, Scan, Copy
2. Print Resolution: 1200x1200 dpi
3. Print Speed: 18 pages per minute
4. Connection: Wireless / WiFi or Direct Connection
5. Warranty: See specification section 23 09 20, section 1.13.
6. Basis-of-Design: Epson – Workforce WF-7710.

2.7 SYSTEM SOFTWARE-GENERAL

A. Functionality and Completeness: The Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.

2.8 CONTROLLER SOFTWARE

A. All bindings, configuration values, addresses, calibration values, parameters, variables, tuning values, gains, test values, etc. for all software, programs, network configurations etc. shall be exposed and be available for setup, manipulation, adjustment, calibration, testing, etc. at all workstations, CSS's/OWS's, POT's for use as allowed via applicable password protection for all controllers and devices throughout all networks and the entire BAS.

B. Building Controller (BC) Software Residency: Each BC as defined below shall be capable of control and monitoring of all points physically connected to it. All software including the following shall reside and execute at the BC:

1. Real-Time Operating System software
2. Real-Time Clock/Calendar and network time synchronization
3. BC diagnostic software
4. LAN Communication software/firmware
5. Direct Digital Control software
6. Alarm Processing and Buffering software
7. Energy Management software
8. Data Trending, Reporting, and Buffering software
9. I/O (physical and virtual) database
10. Remote Communication software

C. Advanced Application Controller (AAC) Application Specific Controller (ASC) Software Residency: Each AAC/ASC as defined below shall be capable of control and monitoring of all points physically connected to it. As a minimum, software including the following shall reside and execute at the AAC/ASC. Other software to support other required functions of the AAC/ASC may reside at the BC or LAN interface device (specified in Division 23 Section

"Building Automation System (BAS) - Communication Devices") with the restrictions/exceptions per application provided in Division 23 Section "Building Automation System (BAS) - Field Panels":

1. Real-Time Operating System software
2. AAC/ASC diagnostic software
3. LAN Communication software
4. Control software applicable to the unit it serves that shall support a single mode of operation
5. I/O (physical and virtual) database to support one mode of operation

D. Stand Alone Capability: BC shall continue to perform all functions independent of a failure in other BC/AAC/ASC or other communication links to other BCs/AACs/ASCs. Trends and runtime totalization shall be retained in memory. Runtime totalization shall be available on all digital input points that monitor electric motor status. Refer also to Division 23 Section "Building Automation System (BAS) - Field Panels" for other aspects of stand alone functionality.

E. Operating System: Controllers shall include a real-time operating system resident in ROM. This software shall execute independently from any other devices in the system. It shall support all specified functions. It shall provide a command prioritization scheme to allow functional override of control functions. Refer also to Division 23 Section "Building Automation System (BAS) - Field Panels" for other aspects of the controller's operating system.

F. Network Communications: Each controller shall include software/firmware that supports the networking of CUs on a common communications trunk that forms the respective LAN. Network support shall include the following:

1. Controller communication software shall include error detection, correction, and re-transmission to ensure data integrity.
2. Operator/System communication software shall facilitate communications between other BCs, all subordinate AACs/ASCs, Gateways and LAN Interface Devices or Operator Workstations. Gateways and LAN Interface Devices or CSS's/OWS's. Software shall allow point interrogation, adjustment, addition/deletion, and programming while the controller is on line and functioning without disruption to unaffected points. The software architecture shall allow networked controllers to share selected physical and virtual point information throughout the entire system.

G. Point Database/Summary Table: All points included in the typical equipment point list must be represented in a common, open protocol format. Naming conventions for these points and network addressing are discussed in PART 3 of this Section. Point/system database creation and modification shall be via a user-friendly, menu-driven program. System software shall support virtual or logic point (points not representing a physical I/O) creation. Software shall support virtual points with all services specified herein. Database software shall support definition of all parameters specified in PART 3 of this Section for a given point type. If database does not support all these parameters, software module shall be created and attached to the points which accomplish the respective function.

H. Diagnostic Software: Controller software shall include diagnostic software that checks memory and communications and reports any malfunctions

I. Alarm/Messaging Software: Controller software shall support alarm/message processing and buffering software as more fully specified below.

J. Application Programs: CUs shall support and execute application programs as more fully specified below:

1. All Direct Digital Control software, Energy Management Control software, and functional block application programming software templates shall be provided in a 'ready-to-use' state, and shall not require (but shall allow) the Owner's programming.
2. Line programs shall supply preprogrammed functions to support these energy management and functional block application algorithms. All functions shall be provided with printed narratives and/or flow diagrams to document algorithms and how to modify and use them.

K. Security: Controller software shall support multiple level password access restriction as more fully specified below.

L. Direct Digital Control: Controller shall support application of Direct Digital Control Logic. All logic modules shall be provided pre-programmed with written documentation to support their application. Provide the following logic modules as a minimum:

1. Proportional-Integral-Derivative (PID) control with analog, PWM and floating output
2. Two Position control (Hi or Low crossing with deadband)
3. Single-Pole Double-Throw relay
4. Delay Timer (delay-on-make, delay-on-break, and interval)
5. Hi/Low Selection
6. Reset or Scaling Module
7. Logical Operators (And, Or, Not, Xor)

M. Psychrometric Parameters: Controller software shall provide preprogrammed functions to calculated and present psychrometric parameters (given temperature and relative humidity) including the following as a minimum: Enthalpy, Wet Bulb Temperature.

N. Updating/Storing Application Data: Site-specific programming residing in volatile memory shall be uploadable/downloadable from an OWS or CSS connected locally, to the Primary LAN, to the Local Supervisory LAN and remotely via the internet and modem and telephone lines as applicable but all must be available. Initiation of an upload or download shall include all of the following methods; Manually, Scheduled, and Automatically upon detection of a loss or change.

O. Restart: System software shall provide for orderly shutdown upon loss of power and automatic restart upon power restoration. Volatile memory shall be retained; outputs shall go to programmed fail (open, closed, or last) position. Equipment restart shall include a user definable time delay on each piece of equipment to stagger the restart. Loss of power shall be alarmed at operator interface indicating date and time.

P. Time Synchronization: Operators shall be able to set the time and date in any device on the network that supports time-of-day functionality. The operator shall be able to select to set the time and date for an individual device, devices on a single network, or all devices simultaneously. Automatic time synchronization shall be provided.

Q. Misc. Calculations: System software shall automate calculation of psychometric functions, calendar functions, kWh/kW, and flow determination and totalization from pulsed or analog inputs, curve-fitting, look-up table, input/output scaling, time averaging of inputs and A/D conversion coefficients.

2.9 APPLICATION PROGRAMMING DESCRIPTION

A. The application software shall be user programmable.

B. This specification generally requires a programming convention that is logical, easy to learn, use, and diagnose. General approaches to application programming shall be provided by one, or a combination, of the following conventions:

1. Point Definition: provide templates customized for point type, to support input of individual point information.
2. Graphical Block Programming: Manipulation of graphic icon 'blocks', each of which represents a subroutine, in a functional/logical manner forming a control logic diagram. Blocks shall allow entry of adjustable settings and parameters via pop-up windows. Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time block output values.
3. Functional Application Programming: Pre-programmed application specific programs that allow/require limited customization via 'fill-in-the-blanks' edit fields. Typical values would be setpoints gains, associated point names, alarm limits, etc.
4. Line Programming: Textual syntax-based programming in a language similar to BASIC designed specifically for HVAC control. Subroutines or functions for energy management applications, setpoints, and adjustable parameters shall be customizable, but shall be provided preprogrammed and documented.

C. Provide a means for testing and/or debugging the control programs both off-line and on-line.

2.10 ENERGY MANAGEMENT APPLICATIONS

A. System shall have the ability to perform all of the following energy management routines via preprogrammed function blocks or template programs. As a minimum provide the following whether or not required in the software:

1. Time-of-Day Scheduling
2. Calendar-Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start/Optimal Stop-based on space temperature offset, outdoor air temperature, and building heating and cooling capacitance factors as a minimum
6. Night Setback and Morning Recovery Control, with ventilation only during occupancy
7. Economizer Control (enthalpy or dry-bulb)
8. Peak Demand Limiting and Load Shedding. The demand limiting function shall use demand data as the basis for the function and the load shedding program shall use space temperature adjustment or means acceptable to the Owner to provide load shedding response. The function selected for a given location shall be made by the Owner.
9. Dead Band Control

B. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow operator customization. For example the load shedding program shall allow the operator to determine the spaces to be included in the load shed as well as the duration of the event. Programs shall be applied to building equipment as described in the Division 23 Section "Building Automation System (BAS) - Sequence of Operation."

2.11 PASSWORD PROTECTION

A. Multiple-level password access protection shall be provided to allow the Owner's authorized BAS Administrator to limit workstation control, display and database manipulation capabilities as deemed appropriate for each user, based upon an assigned user name with a unique password.

B. All passwords for the system shall be provided to the Owner including administrator, dealer, or factory level passwords for the systems provided under this project.

C. Passwords shall restrict access to all Control Units.

D. Each user name shall be assigned to a discrete access level. A minimum of five levels of access shall be supported. Alternately, a comprehensive list of accessibility/functionality items shall be provided, to be enabled or disabled for each user.

E. A minimum of 20 user names shall be supported and programmed per the Owner's direction. Provide ability to deactivate passwords without removal of the login and password. The Owner shall be provided with the highest level login and password so that the Owner controls the administrative passwords.

F. Operators shall be able to perform only those commands available for the access level assigned to their user name.

G. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving interface device software on-line. This timer shall not be the windows system screen saver feature.

2.12 ALARM AND EVENT MANAGEMENT REPORTING

A. Alarm management shall be provided to monitor, buffer, and direct alarms and messages to operator devices and memory files. Each BC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall a BC's ability to report alarms be affected by either operator activity at an Operator Workstation or local handheld device, or by communications with other panels on the network.

1. Alarm Descriptor: Each alarm or point change shall include that point's English language description, and the time and date of occurrence. In addition to the alarm's descriptor and the time and date, the user shall be able to print, display and store an alarm message to more fully describe the alarm condition or direct operator response.
2. Alarm Prioritization: The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. A minimum of ten priority levels shall be provided. For each priority level, users shall have the ability to enable or disable an audible tone whenever an alarm is reported and whenever an alarm returns to normal condition. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with the Owner on establishing alarm priority definitions.
3. Alarm Report Routing: Each alarm priority level shall be associated with a unique user-defined list of operator devices including any combination of local or remote workstations, printers and workstation disk files. All alarms associated with a given priority level shall be routed to all operator devices on the user-defined list associated with that priority level. For each priority level, alarms shall be automatically routed to a default operator device in the event that alarms are unable to be routed to any operator device assigned to the priority level.
4. Auto-Dial Alarm Routing: For alarm priority levels that include a remote workstation (accessed by modem) as one of the listed reporting destinations, the BC shall initiate a call to report the alarm, and shall terminate the call after alarm reporting is complete. System shall be capable of multiple retries and buffer alarms until a connection is made. If no connection is made, system shall attempt connection to an alternate dial-up workstation. System shall also be able to dial multiple pagers upon alarm activation.

5. Alarm Acknowledgment: For alarm priority levels that are directed to a workstation screen, an indication of alarm receipt shall be displayed immediately regardless of the application in use at the workstation, and shall remain on the screen until acknowledged by a user having a password that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and user name of acknowledging operator) shall be stored in a selected file on the workstation hard disk.
6. Alarm Display: All alarms shall popup as described in Alarm Acknowledgement. The owner shall have the option to limit the pop up alarms based on alarm priority.

B. It shall be possible for any operator to receive a summary of all alarms, regardless of acknowledgement status; for which a particular recipient is enrolled for notification; based on current event state; based on the particular event algorithm (e.g., change of value, change of state, out of range, and so on); alarm priority; and notification class.

C. Alarm Historical Database: The database shall store all alarms and events object occurrences in an ODBC or an OLE database-compliant relational database. Provide a commercially available ODBC driver or OLE database data provider, which would allow applications to access the data using standard Microsoft Windows Data Services.

2.13 TRENDING

A. The software shall display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:

1. Trends may be buffered in the BC as long as the trend data in the BC and the historical data stored on hard disk is displayed seamlessly.
2. Provide trends for all physical points, virtual points and calculated variables.
3. Trend data shall be stored in relational database format as specified in herein under Data Acquisition and Storage.
4. In the graphical format, the trend shall plot at least 4 different values for a given time period superimposed on the same graph. The 4 values shall be distinguishable by using unique colors. In printed form the 4 lines shall be distinguishable by different line symbology. Displayed trend graphs shall indicate the engineering units for each trended value.
5. The sample rate and data selection shall be selectable by the operator.
6. The trended value range shall be selectable by the operator.
7. Where trended values on one table/graph are COV, software shall automatically fill the trend samples between COV entries.

B. Control Loop Performance Trends: Controllers incorporating PID control loops shall also provide high resolution sampling in less than six second increments for verification of control loop performance.

C. Data Buffering and Archiving: Trend data may be buffered at the BC, and uploaded to hard disk storage for archiving as needed based on the BC's memory constraints. All archived trends shall be transmitted to the on-site OWS as applicable. Uploads shall occur based upon a user- defined interval, manual command, or automatically when the trend buffers become full.

D. Time Synchronization: Provide a time master that is installed and configured to synchronize the clocks of all devices supporting time synchronization. Synchronization shall be done using Coordinated Universal Time (UTC). All trend sample times shall be able to be synchronized. The frequency of time synchronization message transmission shall be selectable by the operator.

2.14 DYNAMIC PLOTTING

A. Provide a utility to dynamically plot in real-time at least 4 values on a given 2-dimensional dynamic plot/graph with at least two Y-axes. At least 5 dynamic plots shall be allowed simultaneously.

2.15 DATA ACQUISITION AND STORAGE

A. All points included in the typical equipment point list must be represented in a common, open or accessible format. Naming conventions for these points and network addressing are discussed in the 'Point Naming Conventions' paragraph below.

B. Data from the BAS shall be stored in relational database format. The format and the naming convention used for storing the database files shall remain consistent across the database and across time. The relational structure shall allow for storage of any additional data points, which are added to the BAS in future. The metadata/schema or formal descriptions of the tables, columns, domains, and constraints shall be provided for each database.

C. The database shall allow applications to access the data while the database is running. The database shall not require shutting down in order to provide read-write access to the data. Data shall be able to be read from the database without interrupting the continuous storage of trend data being carried by the BAS.

D. The database shall be ODBC or OLE database compliant. Provide a commercially-available ODBC driver or OLE database data provider, which would allow applications to access the data via Microsoft Windows standard data access services.

E. All data shall be stored for a minimum of 5-years.

2.16 TOTALIZATION

A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator Interfaces to support management-reporting functions.

B. Totalization of electricity use/demand shall allow application of totals to different rate periods, which shall be user definable.

C. When specified to provide electrical or utility Use/Demand, the Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.

2.17 EQUIPMENT SCHEDULING

A. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.

B. Scheduling feature shall include multiple seven-day master schedules, plus holiday schedule, each with start time and stop time. Master schedules shall be individually editable for each day and holiday.

C. Scheduling feature shall allow for each individual equipment unit to be assigned to one of the master schedules.

D. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied

period, whichever comes first. A password level that does not allow assignment of master schedules shall allow a timed override feature.

E. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

2.18 POINT STRUCTURING AND NAMING

A. General: The intent of this Section is to require a consistent means of naming points across the Owner requirements. Contractor shall configure the systems from the perspective of the Enterprise, not solely the local project. The following requirement establishes a standard for naming points and addressing Buildings, Networks, Devices, Instances, and the like. The interface shall always use this naming convention. The naming convention shall be implemented as much as practical. Naming convention shall be clearly documented and approved by the EOR and/or Owner.

B. Point Summary Table

1. The term 'Point' is a generic description for the class of object represented by analog and binary inputs, outputs, and values.
2. With each schematic, Contractor shall provide a Point Summary Table listing:

    a. Building number and abbreviation
    b. System type
    c. Equipment type
    d. Point suffix
    e. Full point name (see Point Naming Convention paragraph)
    f. English language point description
    g. Ethernet backbone network number,
    h. Network number
    i. Device ID
    j. Device MAC address
    k. Engineering units

3. Point Summary Table shall be provided in both hard copy and in electronic format (ODBC-compliant).
4. Point Summary Table shall also illustrate Network Variables Bindings.
5. The Contractor shall coordinate with the Owner's representative and compile and submit a proposed Point Summary Table for review prior to any object programming or project startup.
6. The Point Summary Table shall be kept current throughout the duration of the project by the Contractor as the Master List of all points for the project. Project closeout documents shall include an up-to-date accurate Point Summary Table. The Contractor shall deliver to the Owner the final Point Summary Table prior to final acceptance of the system. The Point Summary Table shall be used as a reference and guide during the commissioning process.
7. The Point Summary Table shall contain all data fields on a single row per point. The Point Summary Table is to have a single master source for all point information in the building that is easily sorted and kept up-to-date. Although a relational database of Device ID-to-point information would be more efficient, the single line format is required as a single master table that shall reflect all point information for the building. The point description shall be an easily understandable English-language description of the point.
8. Point Summary Table shall also illustrate Network Variables/BACnet Data Links Bindings.

Point Summary Table Example

Row Headers and Examples

(Transpose for a single point per row format)

Building Number	0006 (the Owner's 4 digit Building Code)
System Type	Cooling
Equipment Type	Chiller
Point Suffix	CHLR1KW
*Point Name (Object Name)	0006.COOLING.CHILLER.CHLR1KW
*Point Description (Object Description)	Chiller 1 kW
Ethernet Network Number	600
Network Number	610
Device ID	1024006
Device MAC address	24
Point Type	AI
Instance Number	4
Engineering Units	KW
Network Variable?	True
Server Device	1024006
Client Devices	1028006

* Represents information that shall reside in the property for the point

C. Point Naming Convention

1. All point names shall adhere to the format as established below. Said objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS point, a specific and unique name shall be required.
2. For each point, four (4) distinct descriptors shall be linked to form each unique object name: Building, System, Equipment, and Point. All keyboard characters except a space are allowable. Each of the four descriptors must be bound by a period to form the entire object name. Reference the paragraphs below for an example of these descriptors.
3. The Owner shall designate the *Building* descriptor. The *System* descriptor shall further define the object in terms of air handling, cooling, heating, or other system. The *Equipment* descriptor shall define the equipment category; e.g., Chiller, Air Handler, or other equipment. The *Point* descriptor shall define the hardware or software type or function associated with the equipment; e.g., supply temperature, water pressure, alarm, mixed air temperature setpoint, etc. and shall contain any numbering conventions for multiples of equipment; e.g., CHLR1KW, CHLR2KW, BLR2AL (Boiler 2 Alarm), HWP1ST (Hot Water Pump 1 Status).
4. A consistent object (point) naming convention shall be utilized to facilitate familiarity and operational ease across the Owner's WAN. Inter-facility consistency shall be

maintained to ensure transparent operability to the greatest degree possible. The table below details the object naming convention and general format of the descriptor string.

Point Name Requirements

Descriptors		Comment
Building Number	0006	The Master Building List also has the correct number for each building.
System	AIRHANDLING	
	EXHAUST	
	HEATING	Boilers and ancillary equipment
	COOLING	Chillers and ancillary equipment
	UTILITY	Main electrical and gas meters
	ENDUSE	Specific building loads by type
	MISC	
Equipment	AHU-1	
	BOILERS	Non-specific boiler system points
	CHILLERS	Non-specific chiller system points
	FACILITY	
	TOWERS	
	WEATHER	
Point Suffix	See Input/Output point summary table for conventions	

5. Examples: Within each point name, the descriptors shall be bound by a period. Within each descriptor, words shall not be separated by dashes, spaces, or other separators as follows:
   a. 0006.COOLING.CHILLERS.CHWP1ST
   b. 0006.HEATING.BOILERS.BLR1CFH

D. Device Addressing Convention:

1. BACnet - Network numbers and Device Object IDs shall be unique throughout the network.
2. BACnet - For each BAS object, a specific and unique BACnet object name shall be required.
3. All assignment of network numbers and Device Object IDs shall be coordinated with the Owner.
4. Each Network number shall be unique throughout all facilities and shall be assigned in the following manner unless specified otherwise:
   a. BBBFF, where: BBB = 1-655 assigned to each building, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building.

5. Each Device Identifier property shall be unique throughout the system and shall be assigned in the following manner unless specified otherwise:
    a. XXFFBBB, where: XX = number 0 to 40, FF = 00 for building backbone network, 1-35 indicating floors or separate systems in the building. BBB = 1-655 assigned to each building.
6. The Contractor shall coordinate with the Owner or a designated representative to ensure that no duplicate Device Object IDs occur.
7. Alternative Device ID schemes or cross project Device ID duplication if allowed shall be approved before project commencement by the Owner.

2.19 OPERATOR INTERFACE GRAPHIC SOFTWARE

A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above. The intent of this specification is to require a graphic package that provides for intuitive operation of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis.

B. Graphic software shall support multiple simultaneous screens to be displayed and resizable in a 'Windows'-like environment. All functions excepting text entry functions shall be executable with a mouse.

C. Graphic software shall provide for multitasking such that third-party programs can be used while the OWS software is on line. Software shall provide the ability to alarm graphically even when operator is in another software package.

D. Operating system software shall be Microsoft Windows 8.0 or higher.

E. The software shall allow for the Owner's creation of user-defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics. These graphics shall be capable of displaying all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

F. Screen Penetration: The operator interface shall allow users to access the various system graphic screens via a graphical penetration scheme by using the mouse to select from menus or 'button' icons. All screens shall be accessible out the use of outline type selection screens. Each graphic screen shall be capable of having a unique list of other graphic screens that are directly linked through the selection of a menu item or button icon.

G. Dynamic Data Displays: Dynamic physical point values shall automatically updated at a minimum frequency of 6 updates per minute without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.

H. Point Override Feature: Provide the following:

1. An Operator from a work-station shall have the capability to place an end device under manual control, which shall prevent the control logic from making changes to the end device status, and provide the operator with the ability to position the end device. It must be possible to put a point under manual control and command the point to a specific state or value from a graphic page. Once under manual control the point shall be able to be released to automatic operation from the same graphics page. See the definition of Manual Control in the definition of terms Article in this Section.
2. An Operator from the operator work-station shall have the capability to place a sensor input into test mode. When in test mode, any changes from the physical sensor shall no

longer be recognized and the value reported to control logic shall take a value that is assigned to it by the operator from the operator work-station. It must be possible to put a point in test and assign a test value from a graphic page. See the definition of Test Mode in the definition of terms Article of this Section.

3. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator's user name. A list of points that are currently in an override state shall be available through menu selection. Such overrides or changes shall occur in the control unit, not just in the workstation software. The graphic point override feature shall be subject to password level protection.

I. Dynamic Symbols: Provide a selection of standard symbols that change in appearance based on the value of an associated point.

1. Analog symbol: Provide a symbol that represents the value of an analog point as the length of a line or linear bar.
2. Digital symbol: Provide symbols such as switches, pilot lights, rotating fan wheels, etc. to represent the value of digital input and output points.
3. Point Status Color: Graphic presentations shall indicate different colors for different point statuses. (For instance, green = normal, red = alarm, gray (or '???') for non- response.

J. Graphics Development Package: Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays. The application of the graphic editing shall be controlled by password level at the programmer level or higher.

1. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
2. The Graphic Development Package shall use a mouse or similar pointing device to allow the user to perform the following:

a. Define symbols
b. Position items on graphic screens
c. Attach physical or virtual points to a graphic
d. Define background screens
e. Define connecting lines and curves
f. Locate, orient and size descriptive text
g. Define and display colors for all elements
h. Establish correlation between symbols or text and associated system points or other displays.
i. Create hot spots or link triggers to other graphic displays or other functions in the software.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF CONTROL NETWORK SYSTEMS:

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Contractor shall fully configure and provide all interface devices and software to provide an integrated system.

C. Contractor shall closely coordinate with the Owner to establish an IP address and communications to assure proper operation of the building control system with the Owner's WAN, CSS's, OWS's, and/or OWSs.

D. Coordinate with the Data Contractor prior to construction to assure data infrastructure requirements are communicated to meet the BAS requirements.

3.3 INSTALLATION OF INTERFACES:

A. Set up the workstations and printers (where applicable) as indicated. Install all software and verify that the systems are fully operational. Ensure all official licenses are provided for all software.

B. No license, software component, key, etc. or any piece of information required to install, configure, operate, diagnose and maintain the system shall be withheld from the Owner.

C. Install electronic control system Operation and Maintenance Manuals, programming guides, network configuration tools, control shop drawings etc. on each OWS and CSS. Provide interface or shortcuts to guide user to the appropriate information.

D. Set up portable operator terminal (where applicable) and configure it as a remote workstation. Install all software and verify that the system is fully operational.

E. Set up panel-mounted LCD or touchscreen display(s) (where applicable) and configure it to operate the required DDC controllers that it serves. Install all software and verify that the system is fully operational.

F. Install systems and materials in accordance with manufacturer's instructions.

3.4 SYSTEM CONFIGURATION

A. Contractor shall thoroughly and completely configure the BAS software, supplemental software, network communications, CSS, OWS (where applicable), POT (where applicable), printer (where applicable), and remote communications for a fully complete operational system.

3.5 SITE-SPECIFIC APPLICATION PROGRAMMING

A. Provide all database creation and site-specific application control programming as required by these Specifications, national and local standards and for a fully functioning system. Contractor shall provide all initial site-specific application programming, thoroughly document programming, and meet the intent of the written sequences of operation. If a sequence is not clear, in the contractor's opinion, it is the Contractor's responsibility to request clarification at no additional cost to the owner.

B. All site-specific programming shall be fully documented and submitted for review and approval, both prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.

C. This contractor shall include forty hours for the owner, AOR, or EOR to use for final graphical, trending, and adjustments at the end of the warranty period.

D. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project shall be the property of the Owner and shall remain on the workstation(s)/server(s) at the completion of the project.

3.6 PASSWORD SETUP

A. Set up the following password levels to include the specified capabilities:

1. Level 1: (the Owner's BAS Administrator)

   a. Level 2 capabilities
   b. View, add, change and delete user names, passwords, password levels
   c. All unrestricted system capabilities including all network management functions.

2. Level 2: (Programmer)

   a. Level 3 capabilities
   b. Configure system software
   c. Modify control unit programs
   d. Modify graphic software
   e. Essentially unrestricted except for viewing or modifying user names, passwords, password levels

3. Level 3: (Chief Engineer)

   a. Level 4 capabilities
   b. Override output points
   c. Change all setpoints and reset schedules.
   d. Exit BAS software to use third party programs

4. Level 4: (Assistant)

   a. Level 5 capabilities
   b. Acknowledge alarms
   c. Change equipment schedules
   d. Change room temperature setpoints

5. Level 5: (View only Access)

   a. Display all graphic data
   b. Trend point data
   c. Unless otherwise directed the Login shall be the Owner's name and the password shall be "ownerswebaccess".

B. Contractor shall assist the Owner's operators with assigning user names, passwords and password levels. There may be multiple login name and passwords for a given password level. The contractor shall be responsible for changing BAS administrator and Programmer level passwords if those are accidentally provided to other contractors or the Owner.

3.7 POINT PARAMETERS

A. Provide the following minimum programming for each analog input:

1. Name
2. Address
3. Scanning frequency or COV threshold
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. High and low alarm values and alarm differentials for return to normal condition

7. High and low value reporting limits (reasonableness values), which shall prevent control logic from using shorted or open circuit values.
8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred. All default values shall be provided in list format for evaluation by the Owner.
9. Selectable averaging function that shall average the measured value over a user selected number of scans for reporting.

B. Provide the following minimum programming for each analog output:

1. Name
2. Address
3. Output updating frequency
4. Engineering units
5. Offset calibration and scaling factor for engineering units
6. Output Range
7. Default value to be used when the normal controlling value is not reporting.

C. Provide the following minimum programming for each digital input:

1. Name
2. Address
3. Engineering units (on/off, open/closed, freeze/normal, etc.)
4. Debounce time delay
5. Message and alarm reporting as specified
6. Reporting of each change of state, and memory storage of the time of the last change of state
7. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.

D. Provide the following minimum programming for each digital output:

1. Name
2. Address
3. Output updating frequency
4. Engineering units (on/off, open/closed, freeze/normal, etc.)
5. Direct or Reverse action selection
6. Minimum on-time
7. Minimum off-time
8. Status association with a DI and failure alarming (as applicable)
9. Reporting of each change of state, and memory storage of the time of the last change of state.
10. Totalization of on-time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
11. Default value to be used when the normal controlling value is not reporting.

3.8 TRENDS

A. Contractor shall establish and store trend logs at the CCS server. Trend logs shall be prepared for each physical input and output point. All dynamic virtual points such as setpoints subject to

a reset schedule, intermediate setpoint values for cascaded control loops, and the like shall be trended as directed by the Owner

B. The Owner shall be able to analyze trend logs of the system operating parameters to evaluate normal system functionality. Contractor shall establish these trends and ensure they are being stored properly.

1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.

C. Sample times indicated as COV (±) or change-of-value mean that the changed parameter only needs to be recorded after the value changes by the amount listed. When outputting to the trending file, the latest recorded value shall be listed with any given time increment record. The samples shall be filled with the latest values also if the points include different time intervals. If the BAS does not have the capability to record based on COV, the parameter shall be recorded based on the interval common to the unit.

D. Trending intervals or COV thresholds shall be dictated by the Owner or their representative, upon system start-up.

E. The Contractor shall demonstrate functional trends as specified for a period of 30 days after successful system demonstration before final acceptance of the system. The trend limit is 1 year from demonstration for LEED projects that require trend data for M&V purposes. The limit on the length of trend data shall be a function of the storage capacity of the computer.

3.9 TREND GRAPHS

A. Prepare controller and workstation software to display graphical format trends. Trended values and intervals shall be the same as those specified

B. Lines shall be labeled and shall be distinguishable from each other by using either different line types, or different line colors.

C. Provide a legend identifying the line color and symbol along side the point noun name for each point in the trend. Also, indicate engineering units of the y-axis values; e.g. degrees F., inches w.g., Btu/lb, percent open, etc.

D. The y-axis scales shall be chosen so that all trended values are in a readable range. Do not mix trended values on one graph if their unit ranges are incompatible.

E. Trend outside air temperature, humidity, and enthalpy during each period in which any other points are trended except for control loop performance trends.

F. Allow point groups to be saved for future trends. For example HW supply and return temperatures along with HX stm valve position and pump status.

3.10 ALARMS

A. Override Alarms: Any point that is overridden through the override feature of the graphic workstation software shall be reported as a Level 3 alarm.

B. Analog Input Alarms: For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits. Report a ‘Return-to- Normal’ message after the analog value returns to the normal range, using a programmed alarm

differential. The alarm limits shall be individually selected by the Contractor based on the following criteria:

1. Level-3: Space temperature (except as otherwise stated in sequence of operation)

   a. Low alarm: 64°F
   b. Low return-to-normal: 68°F
   c. High alarm: 85°F
   d. High return-to-normal: 80°F

2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, steam converter leaving water temperature, condenser water supply, chilled water supply, etc.): Level 3 (If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint)

   a. Low alarm: 3°F below setpoint
   b. Low return-to-normal: 2°F below setpoint
   c. High alarm: 3°F above setpoint
   d. High return-to-normal: 2°F above setpoint.

3. Level-4: AHU mixed air temperature (where applicable)

   a. Low alarm: 45°F
   b. Low return-to-normal: 46°F
   c. High alarm: 90°F
   d. High return-to-normal: 89°F

4. Level-4: Duct Pressure:

   a. Low alarm: 0.5” w.g. below setpoint
   b. Low return-to-normal: 0.25 ”w.g. below setpoint
   c. High alarm: 0.5” w.g. above setpoint
   d. High return-to-normal: 0.25” w.g. above setpoint

5. Level-4: Space humidity:

   a. Low alarm: 35%
   b. Low return-to-normal: 40%
   c. High alarm: 75%
   d. High return-to-normal: 70%

C. Status versus Command Alarms: The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the ‘Auto’ position. BAS shall enunciate the following Level 5 alarm message if status indicates a unit is operational when the run command is not present or vice versa:

1. *DEVICE XXXX* FAILURE: Status is indicated on *{the device}* even though it has been commanded to stop. Check the HOA switch, control relay, status sensing device, contactors, and other components involved in starting the unit. Acknowledge this alarm when the problem has been corrected.

D. Maintenance Alarms: Enunciate Level 5 alarms when runtime accumulation exceeds a value specified by the operator.

1. *DEVICE XXXX REQUIRES MAINTENANCE*. Runtime has exceeded specified value since last reset.

E. See requirements for additional equipment-specific alarms specified in Division 23 Section "Building Automation System (BAS) - Sequences of Operation."

3.11 GRAPHIC SCREENS

A. Main Screen: The Main screen shall be the first screen displayed after login, no navigation required to get to the main screen. This screen shall have the following features:

1. The Owner shall have the option of providing a picture for the background.
2. There shall be a link button to the floor plans, Summary screen, and system schematic screens. In the event that there are more 10 to 15 AHU, Boiler and Chiller screens a button to groups of AHU's shall be provided.
3. Manufacturer/Installer Logo or information is not to be included in the screen.
4. Provide a global command to open heating or cooling valves to facilitate Test Adjust and Balance. The command shall be grouped so that an AHU can be balanced as well as total system balancing. The same function shall apply for VAV AHU's were all the boxes can be set at minimum or maximum flow.

B. Floor Plan Screens: The contract document drawings shall be made available to the Contractor in AutoCAD format upon request. These drawings may be used only for developing backgrounds for specified graphic screens; however the Owner does not guarantee the suitability of these drawings for the Contractor's purpose.

1. Provide graphic floor plan screens for each floor and/or wing of the building. Indicate the location of all equipment that is not located on the equipment room screens.

    a. Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens.
    b. Display the space temperature point adjacent to each temperature sensor symbol along with the room set point. Use a distinct line symbol to demarcate each terminal unit zone boundary. Use distinct background colors for each zone to demarcate the parent air-handling unit to which it is associated.
    c. Indicate room numbers as provided by the Owner. Verify final room number/name assignments, as these are often different than initially assigned room numbers on the contract drawings.
    d. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding zone equipment schematic graphic screen. Because the area available for the floor plans varies from system to system, the size of text used to display data such as room number and temperature shall be at least 1/8" high on the screen when the entire floor plan section is displayed.
    e. The floor plan graphics shall also indicate the location of control panels. For control devices such as duct smoke detectors, system pressure or differential pressure sensors (water or air), airflow stations that are located outside the equipment rooms. All of these devices shall be linked to the associated system graphic. For terminal units the link to the associated system graphic is sufficient and the associated unit control devices do not need to be located on the floor plan.

2. Provide graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.

3. Provide a graphic building key plan that shall allow navigation at a floor level or from floor to floor. Use elevation views and/or plan views as necessary to graphically indicate the location of all of the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens.
4. When there is more than one building, provide a graphic site plan with links to and from each building plan.

C. System Schematic Screens: Provide graphic system schematic screen for each HVAC subsystem (AHU) controlled with each I/O point in the project appearing on at least one graphic screen. System graphics shall be have the same look as the submittal diagrams (do not use three dimensional graphics) with status, setpoints, current analog input and output values, operator commands, etc. as applicable. Input/output devices shall be shown in their schematically correct locations with the associated value, noun name and engineering units. The position of valves or dampers shall be % OPEN. For three way valves it shall be %OPEN to the device. The noun name (English language descriptors) shall be included for each point on all graphics; this may be accomplished by the use of a pop-up window accessed by selecting the displayed point with the mouse. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen. Similar AHU's shall have the same organization of information.

1. Provide graphic screens for each air handling system. Indicate outside air temperature and enthalpy, and mode of operation as applicable (i.e., occupancy mode and heating, cooling, economizer etc based on the sequence of operations). Link screens for air handlers to the heating system and cooling system graphics. Link screens for supply and exhaust systems if they are not combined onto one screen.
2. Provide a graphic screen for each zone with the associated control devices or terminal unit with a link to the associated system schematic screen of the air handling unit that serves the zone.
3. Provide a cooling system graphic screen showing all points associated with the chillers, cooling towers and pumps. Indicate outside air dry-bulb temperature and calculated wet-bulb temperature. Link the chilled water and condenser water systems screens if they cannot fit onto one cooling plant graphic screen.
4. Link the heating and cooling system graphics to utility history reports showing current and monthly electric uses, demands, peak values, and other pertinent values.
5. For each system schematic screen, including AHU, Boiler, Chiller and terminal unit screen, provide a button linked to a text version of the sequence of operation for the device or system. The sequence shall be updated with the as-built sequence following completion of the demonstration.

D. System Summary Screens: On each graphic System Screen, provide drawing links to the graphic air handling unit schematic screens.

1. Where applicable, provide a chilled water valve screen showing the analog output signal of all chilled water valves with signals expressed as percentage of fully open valve (percentage of full cooling). Indicate the discharge air temperature and setpoint of each air handling unit, cooling system chilled water supply and return temperatures and the outside air temperature and humidity on this graphic. Provide drawing links between the graphic cooling plant screen and this graphic screen.
2. Where applicable, provide a heating water valve screen showing the analog output signal of all air handling unit heating water valves with signals expressed as percentage of fully open valve (percentage of full heating). Indicate the temperature of the controlled

medium (such as AHU discharge air temperature or zone hot water supply temperature) and the associated setpoint and the outside air temperature and humidity.

3. Where applicable, When there are more than one AHU's on the system provide a summary screen with the following type of information for each AHU, each fan command, status, alarms (smoke, freeze, duct static), DAT and duct pressure if applicable. For the heating system provide status and supply water temp or steam pressure and for the chiller provide status and chilled water supply temperature.
4. Provide a BAS system summary screen using the control system riser diagram to show the communication status of all controllers (BC, AAC and ASC's) on the BAS as well as all interface devices such as VFD's, chillers and boiler panels etcetera. Use green board concept, green means communicating, red is not communicating.
5. Provide a terminal unit summary screen grouped by floor or AHU. If the summary is grouped by floor then the AHU shall be shown for each terminal unit and vice versa. The points shown shall depend on the type of terminal unit and shall include room name, floor or AHU, room set point and temperature, DAT, valve position, command status, alarm and occupancy state.
6. Exhaust fans shall be show in a table format showing the command signal, the status, the alarm condition, and the occupancy state.

E. Alarms: Each programmed alarm shall appear on at least one graphic screen. In general, alarms shall be displayed on the graphic system schematic screen for the system that the alarm is associated with (for example, chiller alarm shall be shown on graphic cooling system schematic screen). For all graphic screens, display analog values that are in a 'high alarm' condition in a red color, 'low alarm' condition in a blue color. Indicate digital values that are in alarm condition in a red color. When an alarm first occurs it shall "popup" over the current screen so that the operator is immediately aware of an alarm.

1. Maintenance Alarms

    a. Runtime alarm screen shall list all equipment with a BAS status. For each piece of equipment the screen shall display the current run time (since the last reset), the runtime alarm limit (adj.), its alarm status (red / green) and the total accumulated runtime. The total accumulated runtime would only be zeroed out if the equipment were replaced. For equipment with internal runtime meters ensure that the total accumulative runtime is synchronized.

F. Metering (where applicable): Provide a graphic for the gas, electric and water utility data required in the sequence of operations. This may entail multiple screens if submetering of the gas or electric usage is included in the project.

G. Naming convention shall be clearly documented and approved by the EOR and Owner.

H. All graphical screens, floor plans, alarms, trends, and point parameters shall be clearly documented and approved by the EOR and Owner.

END OF SECTION

SECTION 23 09 24

BUILDING AUTOMATION SYSTEM (BAS) – GENERAL SEQUENCE

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. Refer to Division 23 Section and Control Drawings for a description of the systems to be controlled.

B. Refer to Control Drawings for detailed sequence of operations for major HVAC equipment.

C. This Section contains general sequence and alarming method for the owner.

D. Warranty Period: Refer to specification 23 09 20, section 1.13 for Warranty requirements.

1.2 SUBMITTALS

A. Refer to Division 23 Section "Building Automation System (BAS)" and Division 01 Sections for requirements for control shop drawings, product data, Users Manual, etc.

B. Programming Manual: Provide DDC system programming manual as well as documentation of site specific programming prior to the start of Acceptance Phase.

1.3 PROJECT RECORD DOCUMENTS

A. Within two weeks of the completion of commissioning, provide record documents to represent the final control configuration with actual setpoints and tuning parameters as existed at acceptance.

B. Record documents shall be modified control drawings with the actual installed information. Drawings shall be delivered in both reproducible hard copy and electronic format in AutoCAD v13 or later. Provide all supporting files, blocks, fonts, etc. required by the drawings.

C. Provide final points list

D. Provide final detailed wiring diagrams with all wire numbers and termination points indicated

E. Accurately record final sequences and control logic made after submission of shop drawings.

1.4 DEFINITIONS/ABBREVIATIONS

A. Absolute Minimum OA: Minimum flow rate setpoint to which the OA or primary air may throttle down. This value is acceptable as long as CO_2 levels are within acceptable limits.

B. Design Minimum OA: Minimum flow rate setpoint based on code requirements or designed system and coil capacities.

C. OA: Outdoor Air

D. CHW: chilled water

E. HW: heating water

F. Physical Point: A point on the BAS that is physically connected to an I/O device such that a hardware point exists

G. Virtual Point: A point to store values (i.e.: a setpoint) that do not represent a physical device.

H. The following serves as a general guide of definitions:

1. Acknowledged: Data is broadcast repeatedly until an acknowledgement is received. Used for critical data using one to one bindings only. This type of service shall not be used for one to many bindings.
2. Analog Calibration Offsets: For all analog input measured variables, with the exception of velocity pressure, the value measured by the hardware based analog input point shall be adjusted to match the value reported by a certified test instrument. An analog calibration offset is a parameter that can be added or subtracted from the raw value measured by the sensor to produce a calibrated value used by the control logic and reported to the operator workstations. The initial value of this parameter is set at zero and it is adjusted when the calibration process is executed. This adjustment is referred to as a single point calibration. These parameters are mandatory for all analog inputs except velocity pressure sensors. These offset values are configuration parameters and shall be written to EEPROM. It shall be possible to change the value of these parameters from a graphic page.
3. Application Programming Tool: A vendor unique software tool used to create applications for programmable controllers.
4. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and application user data (ISO 9545).
5. Bandwidth Utilization: The average utilization of the network capacity. Network loading is controlled by the use of event driven broadcast based data propagation and the use of appropriate binding services.
6. Binding Services: When the network management tool within Niagara or Plexus is used to establish a binding, one of the following three types of binding services shall be selected:

    a. Unacknowledged: The data being broadcast is sent one time and an acknowledgement of receipt is not required. Used for non-critical data where there is no significant impact when the receiving device have to wait for the next broadcast.
    b. Unacknowledged Repeated: The data being broadcast is sent three times and an acknowledgement of receipt is not required. Used for most process control related data requiring timely receipt of the data.
    c. Acknowledged: The data is broadcast repeatedly until an acknowledgement is received. Used for critical data using one to one bindings only. This type of service shall not be used for one to many bindings.

7. Binding: The concept of associating an output network variable from one device to the input network variable of a second device. There are three types of bindings:

    a. One to One: A single output network variable is bound to a single input network variable
    b. One to Many: A single output network variable is bound to input network variables on multiple devices.
    c. Many to One: Output network variables from multiple devices are bound to a single input network variable on a different device.

8. Broadcasting: The propagation of data from a device to the control network. Software objects that broadcast data to the network shall include the following parameters:
9. Building Automation System (BAS): The entire integrated energy management and control system.

10. Bus Topology: A term used to describe the sequential connection of devices on a segment. The communication cable runs from device to device with no tees or stubs from the main communication cable to a device.
11. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135-1995).
12. Channel: A network consisting of two segments connected by a physical layer repeater or router configured as a repeater. Each segment can support a theoretical limit of 64 connections.
13. Client: A device that is the requestor of services from a server. A client device makes requests of, and receives responses from, a server device.
14. Configuration Parameter: An input network variable to a controller that is written to the EEPROM.
15. Connection: Made when a device is physically connected to a communication cable. Devices that count against the number of connections limit include adapters, any sensor, actuator, or controller, and a router or repeater. Terminators are not considered to be a connection.
16. Continuous Monitoring: Sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).
17. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and is a PCU.
18. Error Rate: A measurement of communication quality that assesses the number of defective data packets as a percentage of the total number of data packets. Defective data packets are generally the result of poor installation practices or improper cable selection.
19. Event Driven Communication: A term used to describe the propagation of data from a device to the network based on broadcasting rather than polling. The send on delta parameter is used to define the event and the data propagation is further controlled by the minimum and maximum send time parameters.
20. Free Topology: A data wiring topology that allows for loops, tees, y-connections etc. When this topology is used only one terminator of a specific design is required and allowable cable lengths are significantly reduced.
21. Functional Profile: A collection of variables required to define the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.
22. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-1995).
23. Hand Held Device (HHD): Manufacturer's microprocessor based device for direct connection to a Controller.
24. Local Supervisory LAN Interface Device (LANID): Device used to facilitate communication and sharing of data throughout the BAS and the Owner.
25. Media Access Control address (MAC): Hardware address that uniquely identifies each node of a network. Each different type of network medium requires a different MAC layer.
26. Managed Communication: Transmission of data from a controller to a data manager, which in turn re-broadcasts the data to a second controller.
27. Manual Control: Where the operator takes control of an end device and forces a specific position or state. The manual mode and the desired manual position or states are parameters that are set by the operator.
28. Many to One: Output network variables from multiple devices are bound to a single input network variable on a different device.
29. Maximum Send Time Parameter: Parameter used to ensure the periodic update of network data. If a time period equal to the value of this parameter has expired without a

broadcast of the variable, a re-broadcast of the current value shall be executed. See also "Send on Delta" and "Maximum Send Time."

30. Maximum Send Time: Adjustable parameter that defines the maximum time period between broadcasts of a software object's data to the network. Should the value of a software object remain constant over an extended period of time, the value will be rebroadcast once every maximum time period.
31. Minimum Send Time Parameter: Parameter used to control unnecessary broadcasting of data onto the network. Broadcast of an updated value shall not occur unless a time period equal to the value of this parameter has expired. The expiration of the time period does not mandate a re-broadcast. See also "Send on Delta" and "Maximum Send Time" definitions.
32. Minimum Send Time: Adjustable parameter that defines a mandatory time period during which no broadcasting of data will occur. Once this time period has been exceeded without a broadcast, the send on delta parameter or the maximum send time parameter shall determine when a broadcast is initiated.
33. Multiple Controller Integrated Control (MCIC): Where multiple controllers with I/O are used to control a single mechanical system, which is sub-divided into a collection of processes to be controlled. All primary measured variables and the end device associated with a single process along with the primary control logic for the process shall be contained within a single controller. Secondary data from one process that affects the control of another process may be sent from one controller to the primary controller controlling the process. When data is sent from one controller to another controller, broadcasting concepts as defined above must be used. If the data being received over the network only affects the general thermodynamic or psychometric performance of the process but does not have a significant affect on safety or equipment protection then unacknowledged repeated binding services shall be used. If the data being received over the network has a safety or equipment protection impact, then acknowledged repeated binding services shall be used. In both cases peer-to-peer communication is mandatory. All controllers must be on the same channel. Managed communication shall not be used to move data between the multiple controllers.
34. Network Controller: Term used to describe a BAS hardware component that serves several key functions:

    a. Serve as the LANID.
    b. Transmission of data to operator workstations on the TCP/IP network.
    c. Capable of collecting/integrating with different protocol data such as BACnet IP, BACnet MS/TP, Modbus, LON, OPC, etc.
    d. Location for time schedules to support all of the devices.
    e. Location for trend logs for all data to be trended from the devices.
    f. Location for alarm handling software.
    g. Shall process event broadcasted data from the devices (alarm indication) and enter the appropriate alarm information in the alarm reporting system at the TCP/IP level.

35. Open Database Connectivity (ODBC): Open standard application-programming interface (API) for accessing a database, making access to any data, regardless of which database management system (DBMS) is handling the data, possible.
36. Operator Interface (OI): A device used by the operator to manage the BAS.
37. Operator Workstation (OWS): Used to interface with the BAS system via the internet or the Local Supervisory LAN.

38. PANEL LCD OR TOUCHSCREEN DISPLAY (TCP_D): A human-user graphical interface for direct connection to a local group of controllers.
39. Peer-to-Peer Communication: Data is broadcast from its origin and is received by the final device requiring the data without being received and retransmitted by a third device.
40. Polling Communication: The concept of a control device requesting a network variable from a second control device at a specified interval. Polling communication is typically used to populate dynamic data on an active graphic page and for temporary or short term trending of data where the trend data is not stored at the controller level.
41. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.
42. Primary Control Unit (PCU): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems.
43. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, identifying the particular options specified by BACnet that are implemented in the device.
44. Repeater: A physical device used to connect two segments and isolate physical problems. Typically required to allow the use of additional devices or additional cable length.
45. Router: A device that connects two or more networks at the network layer.
46. Send on Delta Parameter: A parameter used to control unnecessary broadcasting of data onto the network. For binary data the send on delta parameter is assumed to be a change of state.
47. Send on Delta: Adjustable parameter that defines a requirement to broadcast when the data generated by the software object changes by an amount that exceeds this parameter's value. For binary data this parameters defaults to a change of state. The broadcast of data is initiated when this criteria and the minimum send time requirement have been met.
48. Smart Device: A control I/O device such as a smart sensor (SS) or smart actuator (SA) that can directly communicate with the controller network to which it is connected rather than through a binary or analog signal.
49. Standardized Query Language (SQL): Standardized means for requesting information from a database.
50. Terminator: An electronic component that consists of a resistive and capacitive circuit specifically designed to enhance the quality of communications on a segment. On a bus topology, a terminator is connected to each end of a segment. For a channel consisting of two bus topology segments, a total of 4 terminators are required, one at each end of each segment.
51. Test Mode: A concept where the operator from the operator workstation can interrupt the flow of data from a sensor to the control logic and insert a mandatory test value or test state to be used by the control logic. The test mode and the desired test value or states are parameters that are set by the operator.
52. Unacknowledged Repeated: The data being broadcast is sent three times and an acknowledgement of receipt is not required. This type of service shall be used for most process control related data requiring timely receipt of the data.
53. Unacknowledged: The data being broadcast is sent one time and an acknowledgement of receipt is not required. This type of service shall be used for non-critical data where there is no significant impact should the receiving device have to wait for the next broadcast.
54. Web Server: Refer to "Control System Server."
55. XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL SEQUENCE NOTES

A. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated.

B. When an air handling unit is not in operation, control devices shall remain in their "off" positions. "Off" positions may differ from the "normal" (meaning failed) position. Except as specified otherwise, "off" and "normal" positions of control devices shall be as follows:

Device	"Off" Position	"Normal" Position
Heating coil valves	closed/ controlling	open
Cooling coil valves	closed	closed
Outside air damper	closed	closed
Return air damper	open	open
Exhaust/relief air damper	closed	closed
Var. Freq. Drive	Off	Min. Speed

C. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified "proportional only" or "P+I", Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.

D. Scheduling Terminology: When air handlers are scheduled throughout the day, the following defines the terminology used:

1. Occupied Period: period of time when the building is in use and occupied. Generally systems will be fully operational throughout this period and ventilation air shall be continuously introduced. Space temperature setpoints will generally be in the "normal" range of 69°-76°F.
2. Unoccupied period: period of time when the building or zone is not in use and unoccupied. Ventilation air shall not be introduced.
3. Preoccupancy Period: Time prior to the Occupied period when the systems are returning the space temperatures from setback to "normal" or occupied setpoints (warm-up and cool-down). Ventilation air shall not be introduced unless outside air conditions permit free-cooling. Time period shall be determined by an optimum start strategy unless otherwise specified.

4. Setback Period: Setback start will typically coincide with the end of the occupied period and end with the start of the preoccupacy period, however it shall be provided with its own schedule. Generally systems will be off except to maintain a "setback" temperature.

E. Temperature-Compensated Duty Cycling

1. The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
2. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

F. Automatic Daylight Savings Time Switchover

1. The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

G. Night Setback Control

1. The system shall provide the ability to automatically adjust setpoints for night control.

H. Enthalpy Switchover (Economizer)

1. The Building Controller Software shall control the position of the air handler relief, return, and outside air dampers. If the outside air enthalpy falls below changeover set point the BCS shall modulate the dampers to provide 100% outside air. The user shall be able to quickly changeover to an economizer system based on dry bulb temperature and shall be able to override the economizer cycle and return to minimum outside air operation at any time.

I. Loop Control

1. A Model-Free Adaptive Control algorithm or alternatively a PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and weighting parameters shall be user-selectable.

J. Staggered Start

1. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable.
2. Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

K. Sequencing

1. Provide application software based upon the sequences of operation specified to properly sequence equipment.

L. All setpoints shall be adjustable (adj.), they shall be modifiable, with the proper password level, from the operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

M. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, one of the following methods shall be employed:

1. Contractor shall determine a fixed reset schedule which shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance.
2. A floating reset algorithm shall be used which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance.
3. [Primary variable shall control the devices directly using a PID feedback control loop without resetting the secondary variable. However, the control devices shall still modulate as necessary to maintain upper and lower limits on the secondary variable. Proportional band, integral gain, and derivative term shall be selected to maintain the primary variable within the specified maximum allowable tolerance while minimizing overshoot and settling time. Contractor shall gain prior approval for implementing this method of reset.]

N. Where a supply air temperature or duct pressure setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, the following method shall be employed:

1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. space temperature) setpoint. The reset increment shall be determined by the quantity of "need heat" or "need cool" requests from individual terminal units. A terminal unit's "need heat" virtual point shall activate whenever the zone's space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A terminal unit's "need cool" virtual point shall activate whenever the zone's space temperature rises above the currently applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values shall limit the setpoint range.

O. Where a supply air temperature, duct pressure, or differential water pressure setpoint is specified to be reset by valve or damper position of the zone or zones calling for the most cooling/heating, the following method shall be employed:

1. A floating reset algorithm shall be used which increments the secondary variable (e.g., supply air temperature, pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. cooling valve, heating valve, damper position) setpoint of 85% open. The reset increment shall be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. The recalculation time, reset increment and control device position influence shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. The BAS analog output value shall be acceptable as indicating the position of the control device.
2. Alternatively to continuously calculating the average of the quantity of worst valve/damper positions, a method similar to the one described above may be employed whereby the "need heat" or "need cool" virtual point shall increment by one unit each time a zone's valve/damper position rises to greater than 95%. The quantity of "need heat" or "need cool" points shall then be the basis for reset.

P. Where "prove operation" of a device (generally controlled by a digital output) is indicated in the sequence, it shall require that the BAS, after an adjustable time delay & after the device is

commanded to operate (feedback delay,) confirm that the device is operational via the status input. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (debounce delay) while the device is commanded to run, an alarm shall be enunciated audibly and via an alarm message at the operator interface and print at the alarm printers. A descriptive message shall be attached to the alarm message indicating the nature of the alarm and actions to be taken. Contractor shall provide messages to meet this intent.

Q. The BAS shall provide for adjustable maximum rates of change for increasing and decreasing output from the following analog output points:

1. Speed control of variable speed drives
2. Chiller supply water temperature setpoint reset
3. Chiller demand limit
4. Travel rate of tower isolation and chiller isolation valves

R. Wherever a value is indicated to be dependent on another value (i.e.: setpoint plus 5°F) the BAS shall use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points shall be provided. One to store the parameter (5°F), one to store the setpoint, and one to store the value which is the result of the equation.

S. Some sequences rely on integration with third-party manufacturer control equipment. See the control equipment specifications, equipment schedules and equipment specifications for more information on this integration.

3.2 GENERAL ALARMING NOTES

A. Override Alarms: Any point that is overridden through the override feature of the graphic workstation software shall be reported as a Level 3 alarm.

B. Analog Input Alarms: For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits. Report a 'Return-to-Normal' message after the analog value returns to the normal range, using a programmed alarm differential. The alarm limits shall be individually selected by the Contractor based on the following criteria:

1. Space temperature, except as otherwise stated in sequence of operation: Level 3

   a. Low alarm: 64°F
   b. Low return-to-normal: 68°F
   c. High alarm: 85°F
   d. High return-to-normal: 80°F

2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, steam converter leaving water temperature, condenser water supply, chilled water supply, etc.): Level 3 (If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint)

   a. Low alarm: 3°F below setpoint
   b. Low return-to-normal: 2°F below setpoint
   c. High alarm: 3°F above setpoint
   d. High return-to-normal: 2°F above setpoint.

3. AHU mixed air temperature: Level 4

   a. Low alarm: 45°F

b. Low return-to-normal: 46°F
c. High alarm: 90°F
d. High return-to-normal: 89°F

4. Duct Pressure:

a. Low alarm: 0.5”w.g. below setpoint
b. Low return-to-normal: 0.25”w.g. below setpoint
c. High alarm: 0.5”w.g. above setpoint
d. High return-to-normal: 0.25”w.g. above setpoint

5. Space humidity:

a. Low alarm: 35%
b. Low return-to-normal: 40%
c. High alarm: 75%
d. High return-to-normal: 70%

C. Status versus Command Alarms: The Sequences of Operation are based on the presumption that motor starter Hand-Off-Auto (HOA) switches are in the ‘Auto’ position. BAS shall enunciate the following Level 5 alarm message if status indicates a unit is operational when the run command is not present or vice versa:

1. *DEVICE XXXX* FAILURE: Status is indicated on *{the device}* even though it has been commanded to stop. Check the HOA switch, control relay, status sensing device, contactors, and other components involved in starting the unit. Acknowledge this alarm when the problem has been corrected.

D. Maintenance Alarms: Enunciate Level 5 alarms when runtime accumulation exceeds a value specified by the operator.

1. *DEVICE XXXX REQUIRES MAINTENANCE*. Runtime has exceeded specified value since last reset.

3.3 DAMPER FAIL POSITION

A. Control dampers shall fail to “safe” position

1. Outdoor air economizer damper – Fail closed
2. “Minimum outdoor air" damper – Fail closed
3. Relief air economizer damper – Fail closed
4. Return air economizer damper – Fail open
5. Exhaust fan dampers – Typically fail closed
6. Associated makeup air dampers – Typically fail closed
7. VAV terminal unit dampers – Typically fail open
8. Face and bypass dampers – Typically fail open to face, closed to bypass

END OF SECTION

SECTION 23 09 25

BUILDING AUTOMATION SYSTEM (BAS) – COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning of the Building Automation System (BAS).

1.2 GENERAL DESCRIPTION

A. Section defines responsibilities of the Controls Contractor to commission the BAS.

B. Owner shall retain a Commissioning Authority (CA) who shall work with the Contractor to ensure that the systems, equipment, and interfaces are installed, tested, and operate in accordance with the design intent; that the systems are adequately documented; and that Owner is adequately trained on system intent, operation, and maintenance.

C. The BAS contractor will provide support the commissioning authority in the form of information, both written and verbal, concerning the installation and operation of the control system.

D. The BAS contractor shall allow time and allocate resources to conduct their own testing including; Point-to-Point Testing, Prefunctional Performances Testing, Functional Performance Testing and finally Demonstration Testing, to the Owner's designated personnel and Commissioning Agent, the operation of all sequences of operation and other control system functions described in this specification, its attachments or drawing references. The tests are intended to provide documentation that all aspects of the temperature control system have been properly installed to meet the design intent of the Owner. The contractor performs all testing, documents all the testing, and submits the documentation prior to approval for conducting Demonstration Testing to the Owner.

E. Air and/or water balancing shall be completed, and discrepancies resolved prior to conducting Demonstration Testing. Controls contractor will coordinate with the Testing & Balancing Contractor if their support is required for the demonstration. The completed testing forms shall be presented to the Owner's representative upon completion of each commissioning step.

1.3 CONTRACTOR RESPONSIBILITIES

A. Perform all testing. This will generally include the following:

1. Attend Commissioning (Cx) progress and coordination meetings.
2. Prepare and submit required draft forms and systems information as required by specification.
3. Establish trend logs and graphs of system operation as specified herein.
4. Demonstrate system operation.
5. Manipulate systems and equipment to facilitate testing.
6. Provide instrumentation necessary for verification and performance testing.
7. Manipulate control systems to facilitate verification and demonstration testing.
8. Train Owner Representatives as specified in PART 3 of this Section.

B. Provide a BAS Technician to work at the direction of Commissioning Authority for software optimization assistance for a minimum of (40) hours Refer to PART 3 for a description of the software optimization.

C. Compensation for Retesting: Contractor shall compensate owner for site time necessitated by incompleteness of systems or equipment at time of functional performance testing. All testing failures, which require on-site time for retesting, will be considered actual damages to the Owner. All parties under contract with the Owner who are affected by the retesting shall be included in the contract modification.

1.4 GENERAL MILESTONES – TEMPERATURE CONTROL WORK

A. The following list outlines the general sequence of events for Temperature Controls commissioning throughout the project:

1. Submittals:

a. Submit product data, including manufacturers' installation and startup procedures, and shop drawings, and receive approval.
b. Submit BAS logic documentation, and receive approval.
c. Submit sample testing forms, and receive approval.
d. Submit O&M Manuals.
e. Submit Training Plan.
f. Submit "The Testing Plan" for review and receive approval.

2. Construction:

a. Begin system installation.
b. Conduct Point-to-Point Testing.
c. Conduct Prefunctional Performance Testing.
d. Work with TAB contractor to complete checking of systems.
e. Conduct Functional Performance Testing.
f. Initiate trend logs.
g. Compile all testing documentation for submission to the Commissioning authority for approval.
h. Conduct Demonstration testing.

3. Acceptance Period:

a. Begin Training.
b. Submit final As-built documentation.
c. Schedule Opposite season testing.
d. Complete training.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Instrumentation required to verify readings and test the system and equipment performance shall be provided by the Contractor. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 6-month period. Certificates of calibration shall be submitted.

2.2 TAB & COMMISSIONING – PORTABLE OPERATORS TERMINAL

A. Contractor shall provide a portable operators terminal or hand held device to facilitate Testing, Adjusting, and Balancing (TAB) and calibration. This device shall support all functions and allow querying and editing of all parameters required for proper calibration and start up.

B. Connections shall be provided local to the device being calibrated. For instance, for VAV boxes, connection of the operator's terminal shall be either at the sensor or at the terminal box.

C. The BAS Contractor shall provide step by step instruction sheets to the TAB contractor for making adjustments required to calibrate controllers or sensors to the system as called for in the TAB contractor's normal work.

PART 3 - EXECUTION

3.1 BAS START-UP, TESTING, ADJUSTING, AND CALIBRATION

A. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems under this Contract, as described below:

1. Inspect the installation of all devices. Verify that all devices were installed in accordance with the manufacturer's written installation instructions.
2. Verify proper electrical voltages and amperages, and verify that all circuits are free from faults.
3. Verify integrity/safety of all electrical connections.
4. Coordinate with TAB subcontractor, and CxA to obtain and fine-tune control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB contractor, and note any TAB deficiencies in the BAS Start-Up Report:
    a. Optimum duct static pressure setpoints for VAV air handling units.
    b. Minimum outside air damper settings for air handling units.
    c. Optimum differential pressure setpoints for variable speed pumping systems.
    d. Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.
        1) BAS contractor shall provide hand-held device as a minimum to the TAB to facilitate calibration. Connection for any given device shall be local to it (i.e. at the VAV box or at the thermostat). Hand-held device or portable operator's terminal shall allow querying and editing of parameters required for proper calibration and start-up.
5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the BAS display and the reading at the device, using an instrument traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range). Record the measured value and displayed value for each device in the BAS Start Up Report.
6. Check and set zero and span adjustments for all transducers and transmitters.
7. For dampers and valves:
    a. Check for adequate installation including free travel throughout range and adequate seal.
    b. Where loops are sequenced, check for proper control without overlap.

8. For Actuators:
    a. Check to ensure that device seals tightly when the appropriate signal is applied to the operator.
    b. Check for appropriate fail position, and that the stroke and range is as required.
    c. For sequenced electronic actuators, calibrate in accordance with manufacturer's instructions to required ranges.
9. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the BAS Start-Up Report.
10. For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters. Coordinate with representative of the respective manufacturer and obtain their approval of the installation.
11. Verify proper sequences by using the approved checklists to record results and submit with BAS Start-Up Report. Verify proper sequence and operation of all specified functions.
12. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
13. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the BAS Start Up Report. Except from a startup, maximum allowable variance from set point for controlled variables under normal load fluctuations shall be as follows. Within 3 minutes of any upset (for which the system has the capability to respond) in the control loop, tolerances shall be maintained (exceptions noted):
    a. Duct Air Temperature: ±1 °F.
    b. Space Temperature: ±2 °F.
    c. Hot Water Temperature: ±3 °F.
    d. Duct Pressure: ± 0.25-inches w.g.
    e. Water Pressure: ±1 psid.
    f. Duct or Space Humidity: ±5%.
    g. Air Flow Control: ±5% of setpoint velocity.
    h. Space Pressurization (on active control systems): ±0.05-inches w.g. with no door or window movements.
14. Interface and DDC Control Panels:
    a. Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
    b. Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
    c. Check power supplies for proper voltage ranges and loading.
    d. Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
    e. Check for adequate signal strength on communication networks.
    f. Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
    g. Ensure that all outputs and devices fail to their proper positions/states.
    h. Ensure that buffered and/or volatile information is held through power outage.

i. With all system and communications operating normally, sample and record update/annunciation times for critical alarms fed from the panel to the Operator Interface.
j. Check for adequate grounding of all DDC panels and devices.

15. For Operator Interfaces:

a. Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
b. Output all specified BAS reports for review and approval.
c. Verify that the alarm, printing, and logging are functional and in accordance with requirements.
d. Verify that trends are archiving to disk and provide a sample to the Commissioning Authority for review.
e. Verify that paging/dial-out alarm annunciation is functional.
f. Verify the functionality of remote Operator Interfaces and that a robust connection can be established consistently.
g. Verify that required third party software applications required with the bid are installed and are functional.

16. Start-up and check out control air compressors, air drying, and filtering systems in accordance with the appropriate Section and with manufacturer's instructions.
17. Verify proper interface with fire alarm system.

B. Submit Start-Up Test Report: Report shall be completed, submitted, and approved prior to Preliminary Acceptance or Substantial Completion.

3.2 SENSOR CHECKOUT AND CALIBRATION

A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2 deg F of each other for temperature and within a tolerance equal to ±2% of the reading of each other for pressure. Tolerances for critical applications may be tighter.

B. Calibration: Calibrate all sensors using one of the following procedures:

1. Sensors Without Transmitters – Standard Application: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
2. Sensors With Transmitters – Standard Application: Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the OI. Record all values and recalibrate controller as necessary to conform to tolerances. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS) is within the tolerances specified. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.

C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to Division 23 Section, "Building Automation System (BAS) - Basic Materials, Interface Devices, and Sensors."

3.3 COIL VALVE LEAK CHECK

A. Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5 deg F of each other. Via the Operator Interface, command the valve to close. Energize fans. After 5 minutes observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3 deg F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing the seat, or replacing the valve as applicable.

3.4 VALVE STROKE SETUP AND CHECK

A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.

B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to not less than three (3) intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

3.5 BAS DEMONSTRATION

A. Demonstrate the operation of the BAS hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority and Owner. Schedule the demonstration with the Owner representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the work fails to be demonstrated to conform to Contract specifications, so as to require scheduling of additional site visits by the Commissioning Authority for re-demonstration, Contractor shall reimburse Owner for costs of subsequent Commissioning Authority site visits.

B. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments and ladders. Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.

C. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner.

D. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:

1. Demonstrate that required software is installed on BAS workstations. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
3. Demonstrate that remote dial-up communication abilities are in accordance with these Specifications.

4. Demonstrate proper installation and functionality of the entire control system. The contractor shall successfully demonstrate using similar techniques used in conducting their own testing the following:
    a. Point-to-Point Testing: A maximum of 10% of all points will be demonstrated to the commissioning authority. Testing. The commissioning authority will randomly select points to be tested.
    b. Prefunctional performance testing: A maximum of 10% of the Prefunctional Checkout Testing will be demonstrated to the commissioning authority. The commissioning authority will randomly select points to be tested.
    c. Functional Performance Testing: A Maximum of 10% of each of the systems: AHU's, VAV, Unit Ventilators, chillers, boilers, etc shall be tested for proper functional performance. Each selected system shall successfully demonstrate all modes of operation as specified in the sequence of operations. The commissioning authority will randomly select which pieces of equipment will be tested.
5. Upon failure of any device or system to meet the specified end-to-end accuracy, an additional 10 percent of those tests shall be selected at random by Commissioning Authority for demonstration. This process shall be repeated until 100 percent of randomly selected point and sequences have been demonstrated to meet specified end-to-end accuracy.
6. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
7. Demonstrate that all DDC programs accomplish the specified sequences of operation.
8. Demonstrate that commands can be initiated through the operator's workstation.
9. Demonstrate that the panels automatically recover from power failures, as specified.
10. Demonstrate that the stand-alone operation of panels meets the requirements of these Specifications. Demonstrate that the panels' response to LAN communication failures meets the requirements specified.
11. Identify access to equipment. Demonstrate that access is sufficient to perform required maintenance.
12. Demonstrate that required trend graphs and trend logs are set up in accordance with the requirements. Provide a sample of the data archive. Indicate the file names and locations.

E. BAS Demonstration shall be completed and approved prior to Preliminary Acceptance or Substantial Completion.

F. Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.

3.6 TREND LOGS

A. Contractor shall configure and analyze all trends required under Division 23 Section "Building Automation System (BAS) - Software and Programming."

3.7 TREND GRAPHS

A. Trend graphs as specified in Division 23 Section "Building Automation System (BAS) - Software and Programming" shall generally be used during the Acceptance Phase to facilitate and document testing. Prepare controller and workstation software to display graphical format trends during the Acceptance Period. Trend graphs shall demonstrate compliance with contract documents.

B. Each graph shall be clearly labeled with HVAC subsystem title, date, and times.

3.8 WARRANTY PHASE BAS OPPOSITE SEASON TRENDING AND TESTING:

A. Trending: Throughout the Warranty Phase, trend logs shall be maintained as required for the Acceptance Period. Contractor shall forward archive trend logs to the Commissioning Authority/Owner for review upon Commissioning Authority/Owner request. Commissioning Authority/Owner will review these and notify contractor of any warranty work required.

B. Opposite Season Testing: Within 6 months of completion of the Work, Commissioning Authority/Owner shall schedule and conduct Opposite Season functional performance testing. Contractor shall participate in this testing and remedy any deficiencies identified.

3.9 BAS OPERATOR TRAINING AND O&M MANUALS

A. General: The training program shall have the following types of training sessions:

1. Basic Operator Workstation and BAS Hardware.
2. BAS Operation and Monitoring
3. Opposite Season or Refresher training

B. Training Sessions: The individual training sessions shall be made up of four-hour sessions of training, between all training types. No more than one session shall be provided each day (without owner approval).

C. Attendees: The training shall be provided to the Owner's designated personnel.

D. Intent: The intent of the training sessions is to clearly and completely instruct the Owner's personnel on all of the functions of the system, with a particular focus on operation of, and troubleshooting capabilities of, the control system.

1. Basic Operator Workstation and BAS Hardware training requirements:

a. Graphic screens operational.
b. Cheat Sheets completed and accepted.

2. BAS Operation and Monitoring:

a. Commissioning Demonstration completed.
b. As-build control documents are updated.
c. Training Manual has been completed and accepted.

3. The BAS contractor shall provide a training plan or syllabus for each four-hour session and the entire plan must be submitted and accepted by the commissioning agent prior to the beginning of training. In addition to the syllabus the contractor shall assemble a training manual for use during the training. This manual shall contain all the information used during the training session. The manual shall contain the following:

a. TRAINING PLAN: The training plan shall be structured as follows:

1) Format shall be an outline broken up into eight four-hour sessions. There is no training plan for the Opposite Season training.
2) The material to be covered shall then be further sub-divided into descriptions of the material to be covered every 15 minutes.
3) The descriptions shall include not only the material to be covered but also its location in the Training Manual including section and page number.

b. TRAINING MANUAL: Refer to Division 23 Section, "Building Automation System (BAS)."

4. Training Performance: During any training session, should the BAS fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated. If during any training session, the trainer debugs more than three (3) items or for longer than 20 minutes total, the training session shall be terminated and the contractor shall not be credited for training that day. The session shall be rescheduled for another date. The re-scheduled training session shall be carried out for the full four hours at no additional cost to the Owner.
5. Documentation of training: After each four-hour session the engineer shall initial and date the items on the test plan that were covered that day. A copy of the documentation shall be maintained in the engineers Training Manual and the contractor shall keep a copy. Follow the requirements of Division 1 for documenting the training.
6. Basic Operator Workstation and BAS Hardware Training:
    a. Brief walk-through of building. In the walkthrough all control components will be identified including identification of all controlled equipment. Use temperature
    b. Brief overview of the various parts of the O&M Manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation.
    c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
    d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
    e. Overview of mechanical systems installed and how the BAS controls them.
    f. Present all site-specific point naming conventions and points lists, back-up sequences, upload/download procedures, and other information as necessary to maintain the integrity of the BAS.
    g. Provide an overview of alarm features, various levels, acknowledging, reporting and clearing.
7. BAS Operation and Monitoring:
    a. Walk through the entire sequence of operation for the BAS (using the final sequence of operations document) and discuss in detail the operation of the BAS system through a 24-hour day including the different scheduling periods and how the BAS operates the associated mechanical systems
    b. Demonstration of controller portable and built-in operator interface device display capabilities.
    c. Guide engineer in the development of at least eight trends that would be of use in trouble shooting a problem, checking for proper operation or addressing hot or cold complaints. These trends could include classroom temperature checks of control loop stability (hot deck temperature setpoint versus actual value).
    d. Provide an overview of workstation reports.
    e. Demonstrate how to create a temporary schedule.
    f. Discuss the operator software overrides, their impact on the BAS, how to check for them and initiate and remove them.
    g. Review of installed components and how to install/replace, maintain, commission, and diagnose them.

END OF SECTION

SECTION 23 11 23

NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Joining materials for piping and tubing.
4. Valves.
5. Pressure regulators.
6. Service meters.
7. Mechanical sleeve seals.
8. Booster pumps.
9. Concrete bases.
10. Grout.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roofs, 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.

D. Anodless Risers and Sweeps: Fittings that can be installed without additional cathodic protection.

1.3 PERFORMANCE REQUIREMENTS

A. Natural-Gas System Pressure within Buildings: 2-psig or less.

B. Operating Pressure Ratings:

1. Piping and Valves: 100-psig minimum unless otherwise indicated.
2. Service Regulators: 65-psig minimum unless otherwise indicated.
3. Operating Pressure of Service Meter: 5-psig minimum unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.
6. Mechanical sleeve seals.
7. Escutcheons.
8. Packaged Gas Boosters: Include certified performance curves with operating points plotted; rated capacities of selected models; and furnished specialties and accessories. Include information on the following:

    a. Piping.
    b. Flexible connectors.
    c. Plug valves.
    d. Inlet check valve.
    e. Pressure gauge.
    f. Pressure switch.
    g. Recirculation loop and valve.
    h. Heat exchanger.
    i. Control panel.

B. Shop Drawings: Include plans, piping layout and elevations, 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 locations of anchors, alignment guides, and expansion joints and loops. Include a site plan, on which natural-gas piping is indicated and coordinated with other services and utilities.

1. Shop Drawing Scale: Not less than 1/4" = 1'-0".
2. Packaged Gas Boosters: Provide detailed shop drawings for packaged gas boosters and accessories. Include plans, elevations, sections, details, and attachment to other work; power, signal, and control wiring diagrams; dimensioned outline drawings of equipment package, identifying center of gravity and including detailed mounting and anchorage provisions; vibration isolation, including detailed fabrication information, attachments to concrete slabs and supported equipment; operation and maintenance data, including emergency, standard operation and maintenance manuals.

C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

D. Installer Qualifications.

E. Welding Certificates.

F. Reports:

1. Field quality-control reports.
2. Startup Reports: Submit reports documenting activities required during startup of gas boosters. Reports shall be submitted within two weeks following completion of startup activities.

3. Training Reports: Submit reports regarding training of Owner's maintenance personnel. Include date(s) of training and list of attendees.

G. Operation and Maintenance Data: For motorized gas valves, pressure regulators, and service meters, include data in emergency, operation, and maintenance manuals.

H. Record Drawings: Indicate, at 1/4" = 1'-0" scale, the actual natural-gas piping installation layout and elevations, sections, 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 anchors, alignment guides, and expansion joints and loops.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an installer that is experienced in the installation of natural-gas piping of the types required for the Project, and whose work has resulted in a record of successful in-service performance. Installer licensed to perform natural-gas piping installation and maintenance in Chicago, IL.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged gas boosters and are based on the specific system indicated.

C. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

E. 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.

F. Packaged Gas Boosters: Installed according to the National Electrical Code (NFPA 70) and the National Fuel Gas Code (NFPA 54).

G. Regulatory Requirements: Natural-gas piping installations shall comply with the International Fuel Gas Code, 2000 edition.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose flammable 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 throughout 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 polyethylene pipes and valves from direct sunlight.

E. Gas Boosters: Retain gas booster shipping flange protective covers and coatings, protect bearings and couplings against damage, and comply with manufacturer's written rigging instructions when handling packaged gas boosters.

1.7 PROJECT CONDITIONS

A. 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 Owner no fewer than seven days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate installation of anchorages for natural-gas systems. 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. Deliver such items to Project site in time for installation and to not cause a delay in the Work.

C. Coordinate requirements for access panels and doors for valves and controls installed concealed behind finished surfaces, and for areas requiring routine maintenance. Comply with requirements in Division 08 Section "Access Doors and Frames."

1.9 WARRANTY

A. Special Warranty: Submit written warranty, executed by the manufacturer and Installer, agreeing to repair or replace components that develop defects in material or workmanship within the specified warranty period.

1. Warranty Period for Natural-Gas Systems: One year from date of [Substantial Completion, or eighteen months from date of shipment, whichever is greater.
2. Warranty Period for Controls and Control Panels: Three years from dated of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the manufacturers indicated for each component:

1. Appliance Flexible Connector: No preference.
2. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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.

3. Bronze Plug Valves:

a. Lee Brass Company.
b. McDonald, A. Y. Mfg. Co.

4. Cast-Iron, Non-lubricated Plug Valves:

a. McDonald, A. Y. Mfg. Co.
b. Mueller Co.; Gas Products Div.
c. Xomox Corporation; a Crane company.

5. Cast-Iron, Lubricated Plug Valves:

a. Flowserve.
b. McDonald, A. Y. Mfg. Co.
c. Mueller Co.; Gas Products Div.
d. R&M Energy Systems, a Unit of Robbins & Myers, Inc.

6. Automatic Gas Valves:

a. ASCO Power Technologies, LP; Division of Emerson.
b. Eaton Corporation; Controls Div.
c. Eclipse Combustion, Inc.
d. Honeywell International Inc.
e. Johnson Controls.

7. Electrically Operated Valves:

a. ASCO Power Technologies, LP; Division of Emerson.
b. Eclipse Combustion, Inc.
c. Goyen Valve Corp.; Tyco Environmental Systems.
d. Magnatrol Valve Corporation.
e. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
f. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

8. Line Pressure Regulators:

a. Eclipse Combustion, Inc.
b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
c. Invensys.
d. Maxitrol Company.
e. Richards Industries; Jordan Valve Div.

9. Appliance Pressure Regulators:

a. Eaton Corporation; Controls Div.
b. Harper Wyman Co.
c. Maxitrol Company.
d. SCP, Inc.

10. Packaged Gas Boosters:

a. Eclipse Inc.
b. Etter Engineering Company, Inc.
c. The Spencer Turbine Company.

11. Dielectric Unions: No preference.
12. Dielectric Flanges: No preference.
13. Mechanical Sleeves: No preference.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A234/A234M 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 aboveground and stainless steel underground.

B. Polyethylene (PE) Pipe: ASTM D2513, SDR 11 (Underground Piping Only).

1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, 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 D2513, SDR 11 inlet. Underground piping to receive factory-applied, three layer coating of epoxy, adhesive, and polyethylene.
b. Casing: Steel pipe complying with ASTM A53/A53M, 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.
h. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink polyethylene sleeves.

4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive and polyethylene.

2.3 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: 0.0.5-psig End Fittings: Zinc-coated steel.
6. Threaded Ends: Comply with ASME B1.20.1.
7. Maximum Length: 72-inches.

B. Y-Pattern Strainers:

1. Body: ASTM A126, 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.

C. Basket Strainers:

1. Body: ASTM A126, Class B, high-tensile 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. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 57-percent free area.
4. CWP Rating: 750-psig.

E. 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.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural-gas pipe.

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.

2.5 MANUAL GAS SHUTOFF VALVES

A. Refer to Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" for where each valve type is applied in various services.

B. 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 indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch diameter and smaller.
6. Service Mark: Valves NPS 1-1/4 to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. 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 Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Body: Complying with ASTM B584.

1. Ball: Chrome-plated bronze.
2. Stem: Bronze; blowout proof.
3. Seats: Reinforced TFE; blowout proof.
4. Packing: Threaded-body packnut design with adjustable-stem packing.
5. Ends: Threaded, flared, or socket as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. CWP Rating: 600-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.

E. Bronze Plug Valves: MSS SP-78.

1. Body: Bronze, complying with ASTM B584.
2. Plug: Bronze.
3. Ends: Threaded, socket, or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125-psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Non-lubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural-gas.
5. Ends: Threaded or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125-psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural-gas.
5. Ends: Threaded or flanged as indicated in Articles "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule."
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125- psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with embossed cover with letters "GAS".
3. Bottom section with base to fit over valve and a minimum 5-inches diameter barrel.
4. Adjustable cast-iron extensions of length required for depth of embedment.
5. Include tee-handle, steel operating wrench with socket end fitting, either valve nut or flat head, with stem of length required to operate valve.

2.6 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Body: Brass or aluminum.
2. Seats and Disc: Nitrile rubber.
3. Springs and Valve Trim: Stainless steel.
4. Normally closed.
5. Visual position indicator.
6. **Electrical** operator for actuation by appliance automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.

1. Pilot operated.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. 120-V ac, 60-Hz, Class B, continuous-duty molded coil, and replaceable.
6. NEMA ICS 6, Type 4, coil enclosure.
7. Normally closed.
8. Visual position indicator.

2.7 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. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 1.5 times the design discharge pressure at shutoff.
9. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
10. Maximum Inlet Pressure: 2-psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 2-psig

2.8 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Minimum Operating-Pressure Rating: 150-psig.
2. Combination fitting of copper alloy and ferrous materials.
3. Insulating materials suitable for natural-gas.
4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:

1. Minimum Operating-Pressure Rating: 150-psig
2. Combination fitting of copper alloy and ferrous materials.
3. Insulating materials suitable for natural-gas.
4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.9 SLEEVES

A. Steel Pipe Sleeves: ASTM A53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.10 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.11 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Stamped-Steel Escutcheons: With set screw and chrome-plated finish.

D. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw, and chrome-plated finish.

E. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.12 LABELING AND IDENTIFYING

A. Detectable Warning Tape: 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 and the word "CAUTION", and colored yellow.

B. Safety Tracer Wire: Metallic core (copper minimum AWG 14) encased in a protective insulated jacket for corrosion protection, detectable by metal detector when tape is buried up to 36-inches deep; colored yellow.

2.13 CONSTANT SPEED, DUPLEX, PACKAGED GAS BOOSTERS

A. Description: Factory-assembled and –tested, packaged gas boosters with duplex pumps, piping, valves, sensors, and controls fully assembled on a structural base.

B. Ratings shall be based on inlet gas at a standard pressure of 14.7-PSIA, 70-deg F temperature, and 0.6-Specific Gravity (SG) natural-gas and 1.0-SG air according to the UL listing.

C. Allowable maximum inlet according to UL Standards i2, 15.2-PSIA or 13-inch water column and nominal 70-deg F.

D. Arrangement: Duplex with two equal-size 100-percent capacity boosters.

E. Steel casing with horizontally-mounted, spark-resistant aluminum alloy impellers mounted directly on heavy-duty extended motor shafts.

1. Inlet connections, 4-inches diameter and smaller, shall be NPT threaded. Inlet connections, 6-inches diameter and larger, shall be ANSI Class 125/150 flanges.
2. Outlet connection, 3-inches and smaller, shall be NPT threaded. Outlet connections, 4-inches diameter shall be NPT threaded or ANSI Class 125/150 flanges. Outlet connections, 6-inches diameter and larger, shall be ANSI Class 125/150 flanges.
3. Casing shall include lifting lugs, rotation inspection port, and isolation pads.

F. Rotation (CW or CCW) and outlet position shall be as indicated.

G. Motor: Explosion-proof, UL listed NEMA Class 1, Division 1, Group D.

1. Fan-cooled. Motor and fan completely enclosed in the sealed steel casing.
2. Thermal overload protection.
3. Electrical connections made in a junction box mounted on the outside of the casing.

4. Motor bearings, factory-lubricated and sealed, specifically designed for radial and thrust loads.

H. Control Panel: UL listed 508A for automatic operation; NEMA ICS 2; compatible with BAS; including the following:

1. Enclosure NEMA 250.
2. 'Power On' light.
3. On/Off switch.
4. Control Voltage: 24-V AC with integral step-down control power transformer.
5. Fused terminal strip.
6. Motor Controllers: Full-voltage, combination magnetic type with under-voltage release feature, motor-circuit-protection-type disconnect (through-the door), and short-circuit protective device.
7. Motor overload protection: Overload relay in each phase.
8. Hand-off automatic switches in cover of control panel.
9. Pilot device for automatic control
10. Duplex, automatic, alternating starter to switch lead booster to lag booster and to two booster operation.
11. Booster failure light.
12. Alarm bell.
13. Alarm bell silencing switch.
14. Remote signal contacts.
15. Differential pressure switch.
16. High suction pressure cutout.
17. Unit suction and discharge pressure gauges.

I. Piping, plug valves, check valves, and flexible connectors as specified herein.

J. Operating Range: Unit shall be capable of continuous operation at no load conditions without damage or overheating.

K. BAS Interface: Provide auxiliary contacts in booster controls to interface with the Building Automation System for the following:

1. On-Off Status of each booster.
2. Alarm.

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. 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(s) affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Underground Installations: Install underground natural-gas piping according to ASTM D2774.

1. Locate natural-gas piping between 18-and 30-inches below finished grade, except in areas subjected to vehicular traffic, where natural-gas piping shall be located between 24- and 30-inches below finished grade. In all cases, when the backfilled trench is to be compacted, the natural-gas piping shall be placed at a depth sufficient to ensure the piping will be covered by not less than 18-inches of backfill material. Comply with requirements in Division 31 Section "Earthwork" for excavating, trenching, and backfilling.
2. At building, PE piping shall extend to a point 12-inches above finished grade with shut-off valve on either end.
3. Install a safety tracer wire along the entire length of underground piping. Extend safety tracer wire to a point 12-inches above finished grade on the outside gas riser.
4. Provide a continuous detectable warning tape 12-inches below finished grade, directly above - the entire length of the underground piping. Install detectable warning tape 6-inches below subgrade under paved areas and slabs.
5. Line the trench bottom with a 3-inches thick bedding layer of clean sand, taking care to ensure the pipe will be uniformly and continuously supported over its entire length. Place PE pipe. Cover pipe with clean sand, not less than 6-inches above top of pipe, prior to backfilling the trench. Cover the sand with not less than 12-inches of excavated soil, free of rocks, frozen clods, or debris greater than 3-inches diameter, prior to compacting the backfilled trench.

C. Steel Piping with Protective Coating (Above Ground Only):

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Replace pipe having damaged protective coating with new pipe.

D. Aboveground Natural-Gas Piping:

1. Pipe Diameter – 2-inches Diameter and Smaller: Steel pipe with malleable-iron fittings and threaded joints.
2. Pipe Diameter – Larger than 2-inches Diameter: Steel pipe with wrought-steel fittings and welded joints.
3. Concealed Piping: All concealed natural-gas piping shall have welded joints.

E. Install fittings for changes in direction and branch connections.

1. Anodeless risers, pieces, or sweeps shall be used when rising up from soil and when penetrating basement walls. Anodeless components shall be secured to the foundation with proper brackets when used as risers.

F. Above-ground, Exterior Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6-inches diameter.
2. Install cast-iron "wall pipes" for sleeves 6-inches diameter and larger.

G. Exterior Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

H. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

I. 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 by Architect 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 surfaces. 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 piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install escutcheons at penetrations of interior walls, ceilings, and floors.

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
c. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
d. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw.
e. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw.
f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping:

a. Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
b. Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
c. Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
d. Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
e. Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

L. Verify final equipment locations for roughing-in.

M. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

N. Drips and Sediment Traps: Provide 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.

O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

P. Concealed natural-gas piping shall be installed according to the International Fuel Code.

Q. Natural-gas piping valves and regulators shall not be installed in concealed spaces.

1. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
2. 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 hoistways.
b. Do not install natural-gas piping in solid walls or partitions.
c. Do not install natural-gas piping underground below building slabs.

R. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

S. Connect branch piping from top or side of horizontal piping.

T. Provide 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.

U. Do not use natural-gas piping as grounding electrode.

V. Provide strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

W. Provide pressure gage upstream and downstream from each pipe regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.5 VALVE INSTALLATION

A. Provide manual gas shutoff valve for each gas appliance ahead of appliance flexible connector. Valve shall be located in same room as equipment.

B. Provide outdoor underground valves with valve boxes.

C. Provide a shutoff valve, acceptable to the authority having jurisdiction, on the outside riser.

D. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

E. Provide anode for metallic valves in underground PE piping.

F. Provide pressure reducing valve at each equipment and appliance with relief piped outdoors.

G. As a minimum install automatic gas shut off valve with alarm or remote operation for kitchen equipment motor hood with fire suppression system.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads according to 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 dry seal 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. Boiler room piping to equipment (includes boilers and water heaters), science lab gas piping, art room equipment (kilns, etc.) and other indoor gas equipment.

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. Flanged Joints: Provide gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.

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. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for Piping and Equipment."

B. Provide 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/: 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. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Provide tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

E. Connect natural-gas piping to booster pump package:

1. Provide suction and discharge pipes equal to, or greater than, the size of the unit connections.
2. Install inlet check valve furnished with the unit.
3. Install accessories shipped loose with the unit.
4. Install piping to allow service and maintenance operations.

F. Electrically ground booster pump package according to Division 26 Section “Grounding and Bonding”.

G. Connect wiring according to Division 26 Section “Conductors and Cables”.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC" for piping and valve identification.

B. Below Grade: Provide detectable warning tape continuously and directly above gas piping, 12-inches below finish grade; 6-inches below sub-grade under pavements and concrete slabs.

C. Provide equipment identifying markers and signs on booster pump packages. Labeling and identification materials are specified in Division 22 “Identification for Plumbing Piping and Equipment”.

3.10 PAINTING

A. Comply with requirements in Division 09 Section, "Painting," for painting interior and exterior natural-gas piping.

3.11 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated or required by contractor or utility company furnished equipment, but not less than 4 inches larger in both directions than supported unit.
2. Provide 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. Provide epoxy-coated anchor bolts for supported equipment where anchor bolts 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.

B. Use 4000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 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 OUTDOOR PIPING SCHEDULE

A. Underground Natural-Gas Piping: Polyethylene (PE) pipe and fittings joined by heat fusion, or mechanical coupling. Service-line riser with tracer wire shall be terminated in an accessible location.

B. Aboveground Natural-Gas Piping: Steel pipe, with joints as indicated in Article, "Outdoor Piping Installation."

3.14 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 the following:

1. Steel pipe with malleable-iron fittings and threaded joints NPS 2 and smaller.
2. Steel pipe with wrought-steel fittings and welded joints NPS 2-1/2 and larger.
3. All concealed natural-gas piping shall be welded.
4. Underground, below building, piping shall not be allowed.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 2 PSIG

A. Aboveground piping shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints smaller or equal to NPS 2.
2. Steel pipe with steel welding fittings and welded joints NPS 2-1/2 and larger.
3. All concealed natural-gas piping shall be in a double wall configuration and vented to the outdoors.

3.16 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, non-lubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, lubricated plug valve.

E. Valves in branch piping for single appliance shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.

3.17 CONTRACTOR STARTUP AND REPORTING

A. Engage a factory-authorized service representative to perform the following startup service:

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping for tightness.
3. Clean strainer.
4. Verify that booster pump controls are correct for the required application.
5. Prepare a written report documenting services performed.

B. Perform the following startup checks for each booster in the package before starting:

1. Verify bearing lubrication.
2. Start motor.
3. Slowly open discharge valves.
4. Adjust settings.

C. Occupancy Adjustments: When requested, within 12-months of[Substantial Completion, perform on-site assistance adjusting boosters to suit actual occupied conditions. Perform two visits to Project outside normal occupancy hours for this purpose.

D. Check piping connections for tightness.

E. Controls: Set for automatic starting, stopping, sequencing, and alarm operations.

F. Final checks before starting: Perform the following preventive maintenance operations:

1. Lubricate bearings.

2. Verify that each booster is free to rotate manually. Do not operate booster if it is bound or drags, until the cause of the trouble has been corrected.

G. Starting procedure for boosters:

1. Prime boosters by opening suction valves and prepare boosters for operation.
2. Open valves so that boosters are not operated against dead shutoff.
3. Start motors.
4. Slowly open discharge valves.
5. Check general operation of boosters and motors.
6. Close valves once there is sufficient flow to prevent over-heating.

H. Review maintenance and troubleshooting data in Maintenance Manuals.

1. Refer to Division 01Sections “Closeout Procedures” and “Operation and Maintenance Data”.
2. Provide a written troubleshooting guide if the Installation and Operation Manual (IOM) does not include one.

3.18 TRAINING AND DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s designated maintenance personnel to adjust, operate, and maintain gas booster packages as specified below.

1. Train Owner’s designated maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining gas boosters. The training shall occur after the startup report has been submitted to the Owner. The trainer shall furnish four IOMs for the use of the Owner’s personnel during training.
2. Review data in IOMs. All required and recommended maintenance will be reviewed as well as operational troubleshooting. If the IOMs do not include a written troubleshooting guide, one shall be provided for each manual.

    a. Refer to Division 01 Section “Closeout Procedures”.
    b. Refer to Division 01 Section “Operation and Maintenance Data”.

3. Schedule training with Owner, through Architect, with at least 7-days advance notice.
4. Training will occur in one 2-hour session on a separate date from the one on which the boosters were started.

B. Demonstrate proper operation of equipment to commissioning agent and the Owner’s designated maintenance personnel, including functional performance requirements under both local and building automation system control, as well as project-specific commissioning requirements.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Dual-temperature heating and cooling water piping.
4. Condenser-water piping.
5. Makeup-water piping.
6. Condensate-drain piping.
7. Blowdown-drain piping.
8. Air vent piping.
9. Safety-valve-inlet and -outlet piping.

1.2 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

B. Concealed Locations: Spaces above ceilings, Spaces in Furred walls

C. 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.

D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

1.3 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. Chilled-Water Piping: 150 psig at 100 deg F.
3. Dual-Temperature Heating and Cooling Water Piping: 150 psig at 250deg F.
4. Condenser-Water Piping: 150 psig at 150 deg F.
5. Makeup-Water Piping: 80 psig at 100 deg F.
6. Air Conditioning Condensate-Drain Piping: 100 deg F
7. Blowdown-Drain Piping: 200 deg F.
8. Air-Vent Piping: 200 deg F.
9. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 SUBMITTALS

A. Product Data: For each type of the following:

1. Pressure-seal fittings.
2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves. Provide valve schedule indicating size and pressure drop.
3. Air control devices.
4. Chemical treatment.
5. Hydronic specialties.

B. Shop Drawings: Detail, at 1/4 scale, the 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 anchors, alignment guides, and expansion joints and loops. Submittal shall be drawn in AutoCad latest edition. Copies of design drawings are not acceptable. Provide both AutoCad files and hard copies."

C. Field quality-control test reports.

1. Submit written reports documenting the activities required to be performed in PART 3. These reports are to be submitted two weeks after the startup is completed.

D. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

E. Record Drawings: Detail, at 1/4 scale, the actual piping installation 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 anchors, alignment guides, and expansion joints and loops. Submittal shall be drawn in AutoCad latest edition. Provide both AutoCad files and hard copies."

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.
3. All welders certificates shall be on file at project site

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.

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 manufacturers:

1. Wrought Copper Tube and Fittings: No preference.
2. Copper or Bronze Pressure-Seal Fittings:
    a. Stadler-Viega.
    b. Nibco
3. Dielectric Unions: No preference.
4. Dielectric Flanges: No preference.
5. Dielectric Flange Kits:
    a. Advance Products & Systems, Inc.
6. Dielectric Couplings: No preference.
7. Dielectric Nipples: 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.

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. Automatic Flow-Control Valves (New Construction Projects Only):

a. Flow Design Inc.
b. Griswold Controls.
c. Nexus

13. Manual Air Vents: No preference.
14. Automatic Air Vents: No preference.
15. Pressure Fill System:

a. Armstrong.
b. Bell and Gossett.
c. Taco.

16. Bladder-Type Expansion Tanks:

a. Amtrol, Inc
b. Armstrong.
c. Bell and Gossett.
d. Taco.
e. Wessels

17. Tangential-Type Air Separator:

a. Armstrong.
b. Bell and Gossett.
c. Taco.

18. Y-Pattern Strainers:

a. Mueller Steam Specialties.
b. Piping Specialties Inc.
c. Spencer.

19. Basket Strainers:

a. Mueller Steam Specialties.
b. Piping Specialties Inc.
c. Spencer.

20. Stainless Steel Bellow, Flexible Connectors:

a. Mason.
b. Metraflex
c. Hyspan

21. Double Spherical, Rubber Flexible Connectors with control rods:

a. Mason.
b. Metraflex
c. Flexicraft

22. 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. Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

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 globe type with calibrated orifice or venturi.
2. Ball: Chrome plated brass or stainless steel.
3. Globe: Brass or stainless steel.
4. Seat: PTFE.
5. End Connections: Threaded or sweat.
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 or globe pattern with calibrated orifice or venturi.
2. Ball: Chrome plated brass or stainless steel.
3. Stem Seals: EPDM O-rings.
4. Disc: Stainless steel
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
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.

G. Automatic Flow-Control Valves (New Construction Projects Only):

1. Body: Brass or ferrous metal.
2. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 250 deg F.

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. See Division 23 chemical treatment specification

2.9 PRESSURE FILL SYSTEM

A. 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.

2.10 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.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with quick opening spring assist hinged cover, bottom drain connection and support legs.
2. End Connections: flanged ends .
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area. Provide second spare strainer and stainless-steel basket.
4. CWP Rating: 125 psig.

C. 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.

D. Double Spherical, Rubber, Flexible Connectors with control rods:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig .
5. Maximum Operating Temperature: 250 deg F.

E. 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 ½" 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 NPS 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.

C. Hot-water heating piping, aboveground, NPS 5 inch 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. Chilled-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. Chilled-water piping, aboveground, NPS 3" to NPS 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.

G. Chilled-water piping, aboveground, NPS 4 inch 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. No Chilled-water piping shall be installed belowground and or within slabs

I. Dual-temperature heating and cooling water piping, aboveground, NPS 2 1/2" and smaller shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure seal joints.

J. Dual-temperature heating and cooling water piping, aboveground, NPS 3" to NPS 4" shall be the following:

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.

K. Dual-temperature heating and cooling water piping, aboveground, NPS 4 inch 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).

L. No dual-temperature heating and cooling water piping shall be installed belowground and within slabs

M. Condenser-water piping, above ground, NPS 2 ½" and smaller, shall be:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.

N. Condenser-water piping, aboveground, NPS 3" to NPS 4" and smaller, 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.

O. Condenser-water piping, aboveground, NPS 4 inch 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).

P. Condenser-water 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.

Q. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure sealed joints.

R. 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.

S. Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints

T. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blow down drain is installed.

U. Air-Vent Piping:

1. Inlet: Same as service where installed.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

V. 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 each branch connection to supply mains, and at supply connection to each piece of equipment.

DELETE LINES C & D IF AUTOMATIC CONTROL VALVES ARE TO BE USED IN THE PROJECT.

C. Install calibrated-orifice, balancing valves at each branch connection to return main.

D. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

E. Install automatic flow control valve at each heating or cooling terminal.

F. Install check valves at each pump discharge and elsewhere as required to control flow direction.

G. Install safety valves at hot-water generators 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.

H. 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 Coordination 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 2-1/2” and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 3” 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, 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 22.

3.4 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.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 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. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

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 tank 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 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.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Flow limiting devices, manual and automatic, shall be line size unless noted otherwise.

C. Install control valves in accessible locations close to connected equipment.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23.

3.8 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 and chemical treatment per 15189 specification.

C. Add initial chemical treatment and maintain water quality as recommended by chemical treatment company for the first year of operation.

3.9 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. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. 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.
5. 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 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 10 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.

3.10 COMMISSIONING AND DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to Division 01 Section "Demonstration and Training."

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining the pressure fill system and other applicable equipment. 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 01 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.
4. Training will occur in one (1) two (2) hour session.

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 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 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. 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.

1.2 DEFINITIONS

A. Buna-N: Nitrile rubber.

1.3 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: For pumps 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. 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.

1.5 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.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

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. Mechanical Seals: One mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Close-Coupled, In-Line Centrifugal Pumps:

a. Armstrong Pumps Inc.
b. Bell & Gossett; Div. of ITT Industries.
c. Taco, Inc.

2. Separately Coupled, Base-Mounted, End-Suction Centrifugal Pumps:

a. Armstrong Pumps Inc.
b. Bell & Gossett; Div. of ITT Industries.
c. Taco, Inc.

3. Automatic Condensate Pump Units:

a. Aurora Pump; Division of Pentair Pump Group.
b. Flowserve Corporation; Div. of Ingersoll-Dresser Pumps.
c. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.

d. MEPCO (Marshall Engineered Products Co.).

2.2 CLOSED – COUPLED IN LINE CENTRIFUGAL PUMPS

A. 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.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections. Provide all iron construction for swimming pool applications.
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. Provide non-ferrous construction for swimming pool applications.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings where available, Oil lubricated; bronze-journal or thrust type if permanently lubricated is not available..

C. Motor: Single speed, with permanently lubricated (less then 5hp) , grease-lubricated (5hp and over) ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.3 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. 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.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide all iron construction for swimming pool applications.
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. Provide non-ferrous impellor for swimming pool applications.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

C. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. EPDM coupling sleeve for variable-speed applications.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

E. 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.

F. Motor: Single speed, with permanently lubricated (5hp and smaller), grease-lubricated (pumps over 5hp)] ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 AUTOMATIC CONDENSATE PUMP UNITS

A. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve 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-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-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. 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 (450-mm) 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 PUMP INSTALLATION

A. Comply with 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 with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration Controls for HVAC." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for Piping and Equipment."

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 with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration Controls for HVAC." Hanger and support materials are specified in Division 23 Section "Hangers and Supports for Piping and Equipment."

F. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. 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 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 22 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 triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

I. Install check valve and gate or ball valve on each condensate pump unit discharge.

J. Install electrical connections for power, controls, and devices.

K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical Systems."

3.6 CONTRACTOR STARTUP AND REPORTING

A. Engage a factory-authorized service representative to perform startup service. Startup service includes the testing, inspections and startup test reports.

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 COMMISSIONING AND DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining chillers. 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 owners personnel during training.
2. 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 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 01 or 23.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes refrigerant piping used for air-conditioning applications.

1.2 SUBMITTALS

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. Filter dryers.
4. Strainers.
5. Pressure-regulating valves.

B. Shop Drawings: Show layout 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.

1. Shop Drawing Scale: 1/4 inch equals 1 foot.

C. Welding certificates.

D. Field quality-control test reports.

1. Submit written 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. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.4 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.

1.5 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.6 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with requirements, provide products 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 (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).

5. Maximum Operating Temperature: 250 deg F (121 deg C).

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 selected in PART 3 piping applications articles.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.

D. 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.

E. Flanged Unions:

1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
2. Gasket: Fiber asbestos free.
3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
4. End Connections: Brass tailpiece adapters for brazed-end connections to copper tubing.
5. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- long assembly.
6. Pressure Rating: Factory test at minimum 400 psig.
7. Maximum Operating Temperature: 330 deg F.

F. Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
2. End Connections:

    a. NPS 2 and Smaller: With threaded-end connections.
    b. NPS 2-1/2 and Larger: With flanged-end connections.

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.

2.4 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, union, or flanged.
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, union, threaded, or flanged.
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: Bolted ductile iron, 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, union, threaded, or flanged.
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: Threaded.
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.

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: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: See Equipment Schedules
6. Superheat: Adjustable.
7. Reverse-flow option (for heat pump applications).
8. End Connections; Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

H. 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.

I. 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.

J. 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.

K. 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.

L. 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. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

M. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.5 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 REFRIGERANT PIPE SIZING:

A. All refrigerant pipe sizing shall be the responsibility of the Contractor in accordance with the equipment manufacturer’s recommendations.

B. Pipe sizing shall be in accordance with the recommendations in the 2010 ASHRAE Handbook – Refrigeration, Chapter 2 – System Practices for Halocarbon Refrigerants.

C. 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.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

C. Hot-Gas and Liquid Lines: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony brazed joints.

D. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.3 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. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

3.4 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. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. 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.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Sections "Building Automation System (BAS)" and "Building Automation System (BAS) - Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. 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 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. 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.

P. 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.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

V. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC."

3.5 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.

D. Threaded Joints: Thread steel 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.

E. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

F. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) 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.

3.7 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 "Performance Requirements" Article.

    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.

3.8 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 (67 Pa). 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 (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.9 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 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Utility set fans.
2. Centrifugal roof ventilators.
3. Upblast propeller roof exhaust fans.
4. Centrifugal wall ventilators.
5. In-line centrifugal fans.

1.2 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. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

D. Field Quality-Control Test 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.

1.3 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.

1.4 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.

1.5 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.7 EXTRA MATERIALS

A. Furnish one set of belts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide diffusers by one of the following:

1. Utility Set Fans:

a. Greenheck.
b. Loren Cook Company.
c. Penn Ventilation.
d. Twin City

2. Centrifugal Roof Ventilators:

a. Greenheck.
b. Loren Cook Company.
c. Penn Ventilation.
d. Twin City

3. Upblast Propeller Roof Exhaust Fans:
   a. Greenheck.
   b. Loren Cook Company.\
   c. Penn Ventilation.
   d. Twin City

4. Centrifugal Wall Ventilators:

   a. Greenheck.
   b. Loren Cook Company.
   c. Penn Ventilation.
   d. Twin City

5. In-line Centrifugal Fans:

   a. Greenheck.
   b. Loren Cook Company.
   c. Penn Ventilation.
   d. Twin City

2.2 UTILITY SET FANS

A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housing: Fabricated of steel with side sheets fastened with a deep lock seam or welded to scroll sheets. Housing discharge arrangement shall be adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

   1. Blade Materials: Steel.
   2. Blade Type: Backward inclined or forward curved.

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{50} of 200,000 hours.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

   1. Service Factor Based on Fan Motor Size: 1.5.
   2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   3. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:

1. Back draft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
2. Access Door: Gasketed door in scroll with latch-type handles.
3. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
4. Inlet Screens: Removable wire mesh.
5. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
6. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

2.3 CENTRIFUGAL ROOF VENTILATORS

A. Description: Direct- or belt-driven centrifugal fans 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. Required for all direct drive fans.
2. EC Motor with Speed Tap adjustable controller.
3. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
4. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
5. Dampers (Fans less then 3000 CFM): Counterbalanced, parallel-blade, back draft dampers mounted in curb base; factory set to close when fan stops.
6. Motorized Dampers (Fans 3000 CFM and higher): Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
7. Specify roof curbs, if they are site fabricated, in Division 07 Section "Roof Accessories."

F. 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.

2.4 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.

1. Damper Rods: Steel with bronze bearings.

C. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. 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:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.

E. 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.

2.5 IN-LINE CENTRIFUGAL 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. Required for all direct drive fans.
2. EC Motor with adjustable speed controller.
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.

2.6 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type: Unless noted otherwise, Open Drip Proof.

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.

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases.

D. Secure roof-mounting fans to roof curbs with cadmium-plated hardware

E. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

F. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch.

G. Install units with clearances for service and maintenance.

H. Label units according to requirements specified in Division 23 Section "Identification for HVAC."

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 "Air 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 for Electrical Systems."

D. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical Systems."

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 01 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 HVAC" 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 HVAC" 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 the fans.

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining chillers. 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 01 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 01 and 23.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.2 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.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room 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.

1.4 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".

1.5 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.

1.6 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.

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.

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.

END OF SECTION

SECTION 23 73 13

MODULAR, INDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes constant and variable-volume, modular air-handling units with coils for indoor installations.

1.2 SUBMITTALS

A. Product Data: For each type of modular indoor air-handling unit indicated. Include the following:

1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics (installation and removal, tool free).
7. Dampers, including housings, linkages, and operators. Dampers and operators must comply with the requirements of Div 15 Building Automation System including the submittal requirements.
8. Accessories.
9. Required access clearances.
10. Wiring Diagrams: Power, signal, and control wiring.

B. Field Quality-Control Test Reports: Field Quality-Control Test 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.

C. Training Reports: Submit reports on training documenting dates and attendance.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

D. ARI Certification: Modular indoor air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI. Coils shall comply with ARI 410, Forced-Circulation Air-Cooling and Air-Heating Coils.

E. Air Handling Unit safety: ETL or UL 1995

F. Air Handling Unit energy use: ASHRAE 90.1

G. Fans: AMCA 210

H. Filter media: ANSI/UL 900 listed Class I or Class II

I. Control wiring: NEC codes & ETL requirements

J. Motors: Federally mandated Energy Policy Act (EPACT).

K. Airflow Monitoring Stations: AMCA 611-95

1.4 DELIVERY, STORAGE AND HANDLING

A. Lift and support units with the manufacturer's designated lifting or supporting points.

B. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

C. Deliver central-station air-handling units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

D. Comply with ASHRAE 62, Section 5 (mold and corrosion resistant casings, filters upstream of wetted surfaces, and drain pan design).

E. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from rain and other sources of moisture by appropriate in-transit and on-site procedures.

F. Follow manufacturer’s recommendations for handling, unloading and storage.

G. Protect, pack and secure loose-shipped items within the air-handling units. Include detailed packing list of loose-shipped items, including illustrations and instructions for application.

H. Protect, pack and secure controls devices, motor control devices and other electronic equipment. Do not store electronic equipment in wet or damp areas even when they are sealed and secured.

I. Separately enclose and protect control panels, electronic or pneumatic devices and variable frequency drives and pack with desiccant bags. Replace the desiccant bags every 60 days. For equipment stored in an environment with a relative humidity greater than 60%, change bags every 30 days. Do not store equipment in wet or damp areas even when they are sealed and secured.

J. Seal openings to protect against damage during shipping, handling and storage.

K. Provide shrink-wrap around entire exterior of indoor equipment. The membrane shall cover the entire top, side and end panel surfaces to fully protect the AHU during shipping and storage. Cover equipment, regardless or size or shape. Tarping is not acceptable.

L. Shrink-wrap equipment including electrical components for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.

M. Ship units that are not shrink wrapped in an enclosed truck or shipping container.

N. Clearly mark each AHU section with its tag number, segment sequence number and direction of airflow. Securely affix safety-warning labels. Use a 3-language format for labels.

O. Storage: Store per AHU manufacturer's written recommendations. Store AHUs indoors in a warm, clean, dry place where the units will be protected from weather, construction traffic, dirt, dust, water and moisture. If units will sit idle for more than 6 months, obtain written recommendations from the manufacturer for long-term storage. Follow these recommendations to ensure warranty coverage.

P. Rigging: Follow manufacturer's written instructions for rigging, off-loading, and use of rigging tools such as spreader bars, forklifts, come-a-longs, and shackles.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

B. Coordinate installation of equipment supports, and roof penetrations.

C. Coordinate size and location of structural-steel support members.

1.6 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. Filters: One set for each modular indoor air-handling unit.
2. Fan Belts: One set for each modular indoor air-handling unit fan.
3. Gaskets: One set for each sectional joint.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide air handlers by one of the following:

1. Carrier.
2. Daikin.
3. Trane Company (The); Worldwide Applied Systems Group.
4. York International Corporation.
5. Aaon

2.2 MANUFACTURED UNITS

A. Air Handling Unit (AHU) consists of a base rail, structural base, insulated casing, access doors, internal components and accessories.

B. Provide AHU to meet the specified levels of performance for scheduled items including airflow, static pressure, cooling capacity, heating capacity, sound, casing leakage, panel deflection and casing thermal performance, including panels and frame members.

C. Provide internal components and accessories specified and scheduled. Components and accessories shall be installed by the AHU manufacturer in an ISO-9002 certified facility.

D. Ship units in one piece. Split units only where necessary for shipping or installation.

E. Manufacture and ship unit in segments small enough to fit through project specific building openings. See drawings.

F. Manufacturer shall provide detailed, step-by-step instructions for disassembly and reassembly.

G. For AHU segments that must be broken down for rigging and installation:

1. Segment shall be disassembled and reassembled by manufacturer's factory-trained service personnel.
2. Manufacturer shall perform a moisture carry over test as indicated below.
3. Manufacturer shall provide a written statement confirming that the unit is built to the manufacturer's factory standards and that the unit will carry the full warranty.

2.3 BASE RAIL

A. Provide a structural base rail under the full perimeter of the unit, formed from G-90 mill galvanized steel. Rail shall provide sufficient clearance to achieve proper external trapping of drain pans for coils and humidifiers taking into account dirty filter conditions. Lifting lug system shall not require additional support for rigging, and shall include lifting lugs at each side of each shipping split and at unit corners. The drain outlet height above the finished floor must be greater than or equal to pressure in inches of water at the coil outlet (P) with dirty filters plus the drain pipe diameter plus the greater of 5inches or (P/2+1). Conditions which allow standing water in the drain pan or require the floor to be chipped out to fit the trap are unacceptable.

2.4 CASING

A. Provide AHU casing that is double wall in its entirety, including roof, walls, floor, drain pan and access doors.

B. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.

C. Provide an insulation system that is resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.

D. Encapsulate insulation with sheet metal.

E. Provide casing with minimum thermal resistance (R-value) of 8.0 BTU/hr-ft2-°F.

F. Liners shall be G90 galvanized steel.

2.5 PRIMARY DRAIN PANS

A. Comply with the stated intent of ASHRAE Standard 62.

B. Provide a stainless steel drain pan under each cooling coil and humidifier.

C. Provide drain connection made of same material as liner at one or both ends of the pan. Weld drain connection to the drain pan. Threaded drain pan joints are acceptable if joints are easily accessible for inspection and service.

D. Insulate plumbing associated with drain pan drains and connections.

E. Provide drain pan under the complete width and length of cooling coil and humidifier sections.

F. Drain pan shall allow visual inspection and physical cleaning on 100% of the pan surface without removal of the coil or humidifier.

G. Extend drain pan downstream of coil a minimum of 10".

H. Provide a minimum of 1" clearance between the drain pan and any coil casing, coil support or any other obstruction.

I. Provide drain pan that allows the design rate of condensate drainage regardless of fan status.

J. Provide drain pan sloped in at least two planes by at least 1/8" per foot toward a single drain location. Locate drain connection at the lowest point of the pan. The pan shall have no horizontal surfaces.

2.6 ACCESS DOORS

A. Provide access door(s) that meet requirements for the AHU casing.

B. Provide inward opening doors on positive pressure areas on the AHU. If doors opening against positive pressure are not available, provide a safety mechanism and warning label to prevent injury to maintenance personnel.

C. Provide a bulb-type gasket around the entire door or doorframe perimeter.

D. Provide continuous stainless steel hinges that permit 180 degrees of door swing.

E. Provide latches with roller cam mechanisms that ensure a tight seal. Rotating knife-edge or "paw" latches are not acceptable.

F. Provide each door with a single handle linked to multiple latching points or a separate handle for each latching point. Doors serving access segments shall have an interior latch handle.

G. Provide access doors with a locking hasp to accommodate a lockout device.

H. Provide non-condensing double-pane viewing windows.

I. Access doors shall be provided on both sides of unit on all sections unless indicated otherwise on drawings or schedules.

2.7 FANS

A. Provide double width double inlet (DWDI) housed fans or single width single inlet (SWSI) plenum fans. See schedule for specific project requirements.

B. Provide fans with airfoil blades unless otherwise noted on the plans or schedules.

C. Provide airfoil blades formed of extruded aluminum. Bent sheet metal blades are not acceptable. Provide an access door in the fan scroll.

D. Provide only airfoil fans that comply with AMCA standard 99 2408 69 and 99 2401 82. Provide an AMCA Seal on airfoil fans. Airfoil fan performance shall be based on tests made in accordance with AMCA standards 210 and comply with the requirements of the AMCA certified ratings program for air performance.

E. Provide fans with the following accessories:

1. Fan inlet screens in the inlets of fan housing (REQUIRED on SWSI plenum fans)
2. Access door inlet screen (on AHU casing)
3. OSHA-compliant belt guard enclosing the fan motor and drive

F. Provide fans with polished steel shafts sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class. Shaft shall be factory coated after assembly with an anti-corrosion coating.

G. Provide fan motor on an adjustable base to allow adjustable and consistent belt tension.

H. Mount the fan and motor assembly on a common adjustable base. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the AHU floor and mount directly to the AHU frame.

I. Provide vibration isolation springs as required by Division 23 Section, “Vibration Controls FOR HVAC."

J. Connect DWDI fans to the unit casing or bulkheads with canvas flexible connection.

K. Provide horizontal thrust restraints between AHU casing and fan housings with end discharge. This requirement applies to the following cases:

1. SWSI fans operating at greater than 3” of total static pressure
2. DWDI airfoil fans operating at greater than 6” of total static pressure
3. DWDI airfoil fans operating at greater than 3” of total static pressure

2.8 BEARINGS AND DRIVES

A. Provide bearings complying with ANSI/AFBMA 9 regarding fatigue life ratings.

B. Provide fan bearings with an average life L10 of at least 200,000 hours.

C. Provide permanently lubricated bearings on forward curved fans smaller than 18." On other fans, provide re-greaseable bearings with hydraulic grease fittings and lube lines extended to the motor side of the fan or to the exterior of the unit (motor side).

D. Provide plenum fans with direct-drive transmissions.

E. Select drives with a 1.5 service factor. Sheaves shall be machined from a close grain cast iron and statically balanced by the manufacturer. Provide a fixed pitch sheave on the motor.

F. Provide fixed pitch sheaves on fans and motors. For fans with motors rated at 15 hp or less, variable pitch sheaves may be provided for start-up, if they are replaced with fixed pitch after final balance is complete.

G. For fans with belt drives and motors rated at 10 hp or greater, provide multiple belt drives. Belts shall be V-type, precision molded, raw edge construction, anti-static, oil-resistant and heat-resistant.

2.9 ELECTRICAL MOTORS

A. Motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.10 HEATING AND COOLING COMPONENTS

A. Provide coils with ratings certified in accordance with ARI Standard 410 for coil capacity and pressure drop. Circuit coils such that the fluid velocity is within the range of certified rating conditions at full design flow.

B. Provide cooling coils with a maximum face velocity of 500 fpm or less as required to ensure that all condensate falls or drips into the drain pan. The coil and drain pan assembly must meet this requirement whenever the humidity ratio is equal to or less than the design entering conditions and the outlet temperature is at the design leaving condition . Face velocity calculations shall be based on the finned area of the coil only.

C. Provide cooling coil segment design that does not require a drain pan in any downstream section to contain the coil condensate. Drain pan shall extend a minimum of 10" downstream of the face of the coil.

D. Coil segment casing shall accommodate full-face height or reduced-face height coils.

E. Provide a minimum of 24" of empty access plenum between coils in series and an easily removable access panel or door on both sides of the access plenum.

F. Special casing considerations for coil segments:

1. Provide panels that are easily removable with standard tools.
2. Access doors adjacent to piping stub-outs shall be located with sufficient clearance for 2 inches of field-applied insulation and field-installed piping connectors and piping accessories. Space shall allow a minimum of 90 degrees of door swing.

G. Provide coils built in their own casing frame. Coil casing frame shall be stainless steel. Tube sheets on each end shall have fully drawn collars to support tubes and to form a protective sheath at the tubes. Horizontal coil casing and support members shall be constructed to drain moisture. Casing and support members shall not block finned area.

H. Coils shall be designed and installed to allow individual removal from the side of the AHU.

I. Provide a stainless steel intermediate drain pan for stacked cooling coils in the downstream position. The intermediate drain pan shall slope in a minimum of two planes toward a single drain connection. Provide a welded drain connection for the intermediate drain pan. Threaded connections are acceptable if they are easily accessible for inspection and service.

J. Extend pipe connections through the AHU casing. Provide a 1/4" FPT, plugged vent or drain tap on each connection. Circuiting shall provide free and complete draining and venting when installed in the unit. Vent and drain connections shall reside on the coil connection extension on the outside of the unit casing.

K. Insulate gap between coil stub out connection and AHU casing with a spool-shaped sleeve grommet. Adhesive rings applied the casing walls are not acceptable.

L. Water and glycol coils shall be designed to operate at 250 psig design working pressure and up to 300° F. Factory test water and glycol coils with 325 psig compressed air under water.

M. Direct expansion (DX) coils shall be designed to conform to the ANSI B9.1 (Safety Code for Mechanical Refrigeration) when operating with a refrigerant pressure not exceeding 250 psig. Factory test direct expansion (DX) coils with 325 psig compressed air under water.

N. Provide water, glycol and DX coils with a tube OD of 5/8”. Tubes shall be mandrel expanded to form fin bond and provide burnished, work-hardened interior surface. Tubes shall have a minimum tube wall thickness of 0.025". Increase wall thickness to 0.035” for pre-heat coils.

O. Provide water, glycol and steam coil headers constructed of heavy seamless copper or brass tubing. System piping connections shall be of steel or red brass. Connections shall have male pipe threads. Header connections (tubes and piping connections) shall be silver-brazed.

P. Provide DX coils with brass distributor and solder-type connections. Suction and discharge connections shall be on the same end. Mount refrigerant specialties outside of unit. Provide DX coils with a hot gas bypass port on the distributor.

Q. Provide coils with extended surfaces (fins) of die-formed, continuous aluminum fins. The fins shall have fully drawn collars to accurately space fins, and to form a protective sheath for the tube. Fins shall be 0.01" thick, maximum spacing of 10 fins per inch.

2.11 FILTERS

A. Provide side loading filters for filter segments located upstream of the coil segment(s) with an access door on both sides through which the filters can be easily loaded. The filters must be installed and removed tool free.

B. Provide face loading filters for segments located downstream of the coil segment(s). Provide an 18” (minimum) access plenum and access doors on both sides of unit.

C. Provide Class 2 or Class 1 filter media per U.L. 900.

D. Provide filter racks constructed of galvanized steel.

E. Provide a rigid filter segment with 12" rigid media rated in accordance with ASHRAE 52, with an efficiency of 80-85% (MERV 13). Provide a pre-filter rack in the rigid filter segment with 2" 30% pleated filters.

F. Provide a flush mounted, factory installed magnahelic differential pressure gage on the drive side of the unit to measure pressure drop across each filter bank individually. Manufacturer shall provide fully functional gauges, complete with tubing.

2.12 DAMPERS

A. Provide dampers by one of the manufacturers listed in Division 23 Section "Building Automation System (BAS) - Operator Interfaces." Dampers shall be sized for the actual project specific design conditions and reviewed by the temperature controls contractor. Barn door damper sizing is unacceptable. If the AHU manufacturer cannot provide one of the exact dampers specified, properly sized for the project, the unit shall be shipped without dampers and contractor shall provide and field install dampers and blank offs.

2.13 FACTORY INSTALLED MOTOR STARTERS

A. Provide motor starter panels and associated components that are UL or ETL listed and that comply with applicable provisions of the National Electric Code.

B. Provide factory mounted and wired starter panels serving fans as indicated on equipment schedule and shown on the drawings. Each starter shall be mounted in a dedicated, NEMA 1 compartment located on the side of its associated fan section. Wiring to motor shall be provided in flexible conduit.

C. Provide the following features in each starter panel:

1. Non-overloading
2. Main power block
3. Motor contactor(s)
4. Individual starter short circuit and overload protection devices
5. Two primary control fuses, one secondary control line size fuse
6. Three phase ambient compensated overload heater elements
7. 115-volt control power transformer with primary and secondary protection
8. Five-point terminal strip for field control connections
9. Factory wired, non-fused or fused main power disconnect, integral with the starter panel
10. Integrated on/off auto switch.
11. Wiring to fan motor

2.14 FACTORY INSTALLED ELECTRICAL ACCESSORIES

A. Provide factory mounted disconnect in a separate NEMA-1 enclosure. Manufacturer shall wire disconnect to motors.

B. Provide a separate and independent power terminal for convenience receptacles and lights, with switches.

C. Provide low temperature fluorescent lights in fan, access, coil, service, outdoor air and mixed air segments including wiring to switches and power.

D. Provide a 120v convenience receptacle on the supply fan segment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIELD PERFORMANCE VERIFICATION

A. AHU Cooling coil moisture carry over:

1. With the AHU operating at maximum design airflow rate ,.
2. Modulate return and outside air dampers to maintain a humidity ratio greater than or equal to the design coil entering conditions
3. Modulate the chiller water valve to maintain a coil leaving temperature equal to or less than the design leaving temperature.
4. Operate the AHU for 4 hours under the above conditions
5. After 4 hours shut the AHU down and inspect the surface downstream of the coil and pan for moisture. If moisture is found determine the cause, repair and retest.

B. Record test data and results in a report. Test data will include trend data at 5 minute intervals documenting the test conditions.

C. Submit a field test report with testing data recorded. Include description of corrective actions taken.

3.3 INSTALLATION

A. General Requirements: Install per industry standards, applicable building codes and manufacturer's written instructions.

B. Temporary use: Use of AHUs for temporary heating, cooling or ventilation is strictly prohibited.

C. Concrete base: Install AHUs on a minimum 4" thick reinforced concrete pad.

D. Access clearance: Install AHUs with sufficient access space around the AHU to meet manufacturer's recommended clearances for regular service access, coil pull and fan removal. As a minimum, this clearance shall equal to the width of the AHU on one side.

E. Filters: Install one complete set of filters for testing, balancing and commissioning. Install second complete set of filters at time of transfer to owner.

F. Coil Segment: Install AHU plumb and level, to ensure free draining and venting through the manufacturer-provided vent and drain on each coil. Follow manufacturer labels for inlet and outlet of coil headers to ensure proper direction of coil fluid flow.

3.4 FIELD INSPECTION

A. AHU Inspection

1. Retain manufacturer's factory-trained and factory-employed service technician to perform an inspection of the AHU and the AHU installation prior to proceeding with fan assembly inspection and startup. Technician shall inspect and verify the following as a minimum:

a. Damage of any kind
b. Level installation of the AHU
c. Proper reassembly and sealing of unit segments at shipping splits.
d. Installation of shipped-loose parts, including filters, and mist eliminators.
e. Proper electrical, ductwork and piping connections
f. Tight seals around wiring, conduit and piping penetrations through AHU casing.
g. Supply of electricity from the building's permanent source
h. Integrity of condensate trap for positive or negative pressure operation
i. Condensate traps charged with water
j. Removal of shipping bolts and shipping restraints
k. Sealing of pipe chase floor(s) at penetration locations.
l. Tightness and full motion range of damper linkages (operate manually)
m. Complete installation of control system including end devices and wiring
n. Cleanliness of AHU interior and connecting ductwork
o. Proper service and access clearances
p. Proper installation of filters
q. Filter gauge set to zero

2. Resolve any non-compliant items prior to authorizing manufacturer to proceed with the inspection of the fan assembly

B. AHU Fan Assembly Inspection and Adjustment

1. AHU Inspection (fan assembly): Engage a manufacturer's factory-trained and factory-employed service technician to perform an inspection of the AHU fan assembly prior to startup. Technician shall inspect and verify the following as a minimum:

a. Fan isolation base and thrust restraint alignment
b. Tight set screws on pulleys, bearings and fan
c. Tight fan bearing bolts
d. Tight fan and motor sheaves

e. Tight motor base and mounting bolts
f. Blower wheel tight and aligned to fan shaft
g. Sheave alignment and belt tension
h. Fan discharge alignment with discharge opening
i. Fan bearing lubrication
j. Free rotation of moving components (rotate manually)

2. Should any of the above need adjustment, engage manufacturer to perform the necessary adjustments to return the items to within factory specifications.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 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 modular indoor air-handling units with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction. Provide ½" thick insulation on condensate piping.

E. Chilled Water & Hot Water Connections: At a minimum connect inlet to coil with isolation valve, y-strainer w/ hose connection, P&T tap, manual air vent, controller-bulb well, thermometer, pressure gauge, drain connection valve, flex connector, and union or flange. At a minimum connect outlet to coil with isolation valve, control valve, calibrated balance valve, P&T tap, manual air vent, thermometer, controller-bulb well, pressure gauge, drain connection valve, flex connector and union or flange. For multiple coils pipe similarly and provide additional calibrated balancing valves to individually balance each coil. See drawings for additional requirements. Utilize a single pressure gauge with isolation valves across the evaporator inlet and outlet in lieu of individual gauges to eliminate gauge error.

F. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Connect to supply and return coil tapings with shutoff valve and union or flange at each connection. Coil piping shall be per drawing details.

G. 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 connections.

H. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. 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 and UL 486B.

3.6 CLEANING

A. Clean unit per manufacturer's recommendation.

3.7 CONTRACTOR STARTUP AND REPORTING

A. Engage manufacturer's factory-trained and factory-employed service technician to startup AHUs. Startup service includes the testing, inspections and startup test reports. Technician shall perform the following steps as a minimum:

1. Energize the unit disconnect switch
2. Verify correct voltage, phases and cycles
3. Energize fan motor briefly ("bump") and verify correct direction of rotation.
4. Re-check damper operation; verify that unit will not operate without both an inlet and an outlet damper open.
5. Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.
6. If AHU is provided with a factory-mounted variable frequency drive (VFD), then retain the VFD manufacturer's factory-trained and factory-employed service technician to inspect, test, adjust, program and start the VFD. Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.
7. Coordinate startup of AHU, controls and VFD with representative personnel from each supplier.
8. Submit a startup report documenting all steps performed and summarizing findings and activities performed.

3.8 DEMONSTRATION AND COMMISSIOINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air handling units.

1. Train Owner's maintenance personnel on procedures and schedules for startup and shutdown procedures as well as regular operation, maintenance requirements, and troubleshooting of the AHU and factory mounted controls including starters, VFD,. 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 including the startup report.
2. 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 trouble shooting. If the IOM does not include a written trouble shooting guide one will be provided. A list of all required maintenance will be provided.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.
4. Training will occur in two (2) separate two (2) hour sessions, neither on the same day the AHU is started up.

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 01 and 23.

END OF SECTION

SECTION 23 81 19

SELF-CONTAINED AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:

1. Direct-expansion cooling.
2. Gas furnace.
3. Economizer outdoor- and return-air damper section.
4. Integral, space temperature controls.
5. Roof curbs.

1.2 DEFINITIONS

A. DDC: Direct-digital controls.

B. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

C. 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.

1.3 SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.

1. Performance at ARI standard conditions and at conditions scheduled (provide EER).
2. Performance at ARI standard unloading conditions and at conditions scheduled (provide EER).
3. Refrigerant type and capacity of unit.
4. Oil capacity of water chiller.
5. Characteristics of safety relief valves.
6. Minimum entering condenser-air temperature
7. Sound data.
8. dimensions
9. unit construction.
10. components
11. options
12. required clearances
13. characteristics
14. furnished specialties
15. accessories.

16. ASHRAE/IESNA 90.1 for energy compliance statement.

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. Wiring Diagrams: Power, signal, and control wiring.

C. 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 RTUs will be attached.
2. Roof openings
3. Roof curbs and flashing.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

F. Submit complete warranty information as described in Article 1.7.

1.4 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with ASHRAE 62.1-2004 for condensate drain pans.
4. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.

C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

D. UL Compliance: Comply with UL 1995.

E. 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. Follow manufacturer’s instructions for unloading, rigging and storage of equipment.

B. Maintain manufacturer's recommended temperature and humidity limits during storage and installation. Protect equipment from dirt, dust and other jobsite contaminants and conditions detrimental to the equipment.

1.6 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period. Provide warranty on materials and labor for 18 months starting from date of delivery, or one year from date of preliminary acceptance, whichever is longer.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of preliminary acceptance.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than ten years from date of preliminary acceptance.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than one year from date of preliminary acceptance.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than one year from date of preliminary acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation.
2. Trane
3. Aaon
4. Daikin
5. YORK International Corporation.

2.2 CAPACITIES AND CHARACTERISTICS:

A. Efficiency:

1. Air conditioners shall have a EER better than ASHRAE Standard 90.1 – latest edition under ARI test procedures. When air conditioners with higher efficiencies then the Standard are scheduled on the drawings, the more efficient value shall be the minimum project requirement.

2.3 CASING

A. General: Casings shall be formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior casing material shall be galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs. Cabinet shall be tested 1000 hour in salt spray test in compliance with ASTM B117.

C. Casing Insulation shall comply with NFPA 90A or NFPA 90B and ASTM C 1071, Type I. Minimum thickness shall be 1/2 inch, with an aluminum foil or neoprene coating on all surfaces in contact with the air stream.

D. Condensate drain pans shall be formed sections of stainless steel, with a minimum ¾" NPT drain connection

2.4 FANS

A. Evaporator fan shall be forward-curved, double-width, double inlet constant volume centrifugal. Fans shall be belt-driven with adjustable pulleys. Bearings shall be sealed and permanently lubricated.

B. Condenser fans shall be propeller, mounted on shaft of permanently lubricated motor.

C. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

D. Provide power exhaust fan.

2.5 COILS

A. Evaporator and condenser refrigerant coils shall incorporate aluminum-plate fins mechanically bonded to seamless copper tubes. Coils shall be factory pressure tested per ARI standards and leak tested at 150 psig.

2.6 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor: Hermetic, reciprocating or scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection. For units more than 7.5 tons, provide two compressors. Motor shall be suction gas cooled.

B. Refrigeration Specialties:

1. Refrigerant Charge: 410A. Units shall be fully charged when delivered to the site.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset compressor motor thermal overload.
6. Service ports installed in compressor suction and liquid lines.

2.7 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2. Filters shall be glass fiber, two-inch thick **(MERV 8).**

2.8 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54. ASHRAE 90.1 – latest edition compliant.

B. Burners: Stainless steel with a minimum thermal efficiency of 80 percent.

1. Fuel: Natural gas.
2. Ignition: Electronically controlled electric spark.

C. Heat-Exchanger: Stainless steel.

D. Combustion system shall be induced-draft with redundant main gas valves.

E. Safeties: Provide high-temperature limit switches, flame rollout switch, flame proving controls and induced draft pressure sensor.

2.9 DAMPERS

A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated with bird screen and hood.

2.10 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.11 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section "Building Automation System (BAS)" and in the controls drawings.

2.12 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.

B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2.13 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards. Roof curb height shall be 14 inches minimum.

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 RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Roof Curb: Install on roof structure, level and secure, according to ARI Guideline B**.** Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

1. Gas Piping: Comply with applicable requirements in Division 23 Section "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.

C. Duct installation requirements are specified in other Division 23 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.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.4 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. Report results in writing.

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. Report results in writing.

B. Tests and Inspections:

1. After installing RTUs 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. Remove and replace malfunctioning units and retest as specified above.

3.5 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of preliminary acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.6 CONTRACTOR STARTUP AND REPORTING

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

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. Verify lubrication on fan and motor bearings.
14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
15. Adjust fan belts to proper alignment and tension.
16. 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.

17. Inspect and record performance of interlocks and protective devices; verify sequences.

18. Operate unit for an initial period as recommended or required by manufacturer.
19. 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.

20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-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.

24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

26. 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.

27. 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.

28. After startup and performance testing and prior to preliminary acceptance, replace existing filters with new filters.

3.7 DEMONSTRATION AND COMMISSIONING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.2 SUBMITTALS

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.

1. Include documentation on refrigerants, including printed statement that refrigerants are free of HCFCs.

B. 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. Wiring Diagrams: For power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

E. Recording(s) of training session(s).

F. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Electric Code, by a qualified testing agency, and marked for intended location and application.

B. 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-latest edition, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-most current version.

1.4 COORDINATION

A. Ground-Mounted Remote Condensing Units: Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Roof-Mounted Remote Condensing Units: Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.5 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. Compressor: Six years from date of Preliminary Acceptance or Substantial Completion.
b. Parts: One year from date of Preliminary Acceptance or Substantial Completion.

1.6 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. Filters: One set for each air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. SANYO North America Corporation; SANYO Fisher Company.
4. Trane; a business of Ingersoll Rand.
5. YORK; a Johnson Controls company.
6. Aaon

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23.
    b. Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.
    c. Enclosure Type: Totally enclosed, fan cooled.
    d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
    e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
    f. Mount unit-mounted disconnect switches on exterior or interior of unit.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-latest edition.
6. Condensate Drain Pans:

    a. Fabricated with one or two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1-latest edition.
        2) Pan Depth: 1 inch, minimum.

    b. Single-wall, non-corrosive non-condensing with moisture tight seal.
    c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

        1) Minimum Connection Size: NPS 1.

7. Air Filtration Section:

    a. Comply with NFPA 90A.
    b. Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
    c. Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
    d. Disposable Panel Filters:

        1) Thickness: 1 inch.
        2) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel, in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll.
    b. Digital or Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Charge: R-410A as scheduled.
    d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub-cooler. Comply with ARI 210/240.

3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to -20 deg F.
6. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with sub-base to control compressor and evaporator fan.

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounted, compressor-condenser components on 4-inches thick, reinforced concrete base that is 4 inches larger, on each side, than unit, with cast-in anchor-bolt inserts. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-In-Place Concrete."

D. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section, "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

E. Install and connect pre-charged refrigerant pipes to component's quick-connect fittings. Install pipes to allow access to unit.

3.2 PIPE CONNECTIONS

A. Pipe installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Pipe installations shall allow space for service and maintenance of system components.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and repeat test until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 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.

3.5 TRAINING AND DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain unit as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining system components. 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 "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.

3. Schedule training with Owner, through Architect, with at least seven days advance notice.

B. Demonstrate proper operation of equipment to commissioning agent, if one, and designated Owner's personnel. The scope of the demonstration shall include functional performance requirements under local control as well as any commissioning requirements in Division 01 and 23.

C. Video record the training session(s). The manufacturer may submit a standard training video or training CD for review as an alternate to recording of the training session. The standard video must be reviewed and accepted by the Owner and Commissioning Authority, if one, for the alternate to be acceptable.

END OF SECTION

SECTION 23 81 27

VARIABLE REFRIGERANT FLOW SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes variable refrigerant flow systems consisting of remote air-cooled and water-cooled heat pump systems, fan coil units, and controllers.

1.2 SUBMITTALS

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.

1. Include documentation on refrigerants, including printed statement that refrigerants are free of HCFCs.

B. Manufacturer shall provide a listing of all deviations from the designed system including equipment quantities, heating/cooling capacities, condenser water flow rates, efficiency ratings, pipe routing, power requirements, accessories, refrigerant weights, etc. Provide a redline markup of this specification section identifying any additional deviations or exceptions from the contract documents

C. Refrigerant Verification Requirements

1. Manufacturer shall review the refrigerant quantities of their systems and confirm compliance with the latest editions of ASHRAE 15 and the local Mechanical Code. This includes verification that the refrigerant weights of each system do not exceed the maximum amount of refrigerant indicated in these codes and standards.
2. If a manufacturer's system exceeds the maximum amount of refrigerant then the manufacturer shall be responsible for the cost of all additional equipment and devices required to comply with the local code requirements of "Machinery Rooms". This room classification shall include, but is not limited to, a dedicated exhaust system and refrigerant monitoring devices.
3. Additional work as a result of a failure to review these requirements shall be the responsibility of the contractor and not result in additional costs to the Owner.
4. Manufacturer review shall be conducted and submitted to the EOR at the time of bid.
5. Provide verification of refrigerant compliance of each system using the table below.

Refrigerant Compliance Table

Refrigerant System Tag	Total Refrigerant Largest Refrigerant Circuit + Refrigerant in System (lbs)	Largest Refrigerant Circuit (lbs)	Refrigerant in System (lbs)	Refrigerant Type and Classification	Maximum Refrigerant Requirement (lbs per 1,000 CF)	Worst Case Room Name	Worst Case Room Name Room Volume (CF)	Actual Pounds of Refrigerant per Cubic Foot (lbs/CF)	Complies with ASHRAE 15	Complies with Local Code	Notes
HP-##	##.#	##.#	##.#	R-410A/A1	26	MECH RM ###	###	##.#	Yes or No	Yes or No	1,2

Notes:

1. Refrigerant in System is the calculated refrigerant in the piping system and connected equipment.

2. Total Refrigerant in calculation includes the largest refrigerant circuit and the refrigerant in the system.

D. Delegated Design Submittal

1. For the design of a VRF system, including analysis data signed and sealed by the qualified professional engineer.
2. Design Calculations - Calculate requirements for selecting indoor and outdoor units and refrigerant piping sizing and refrigerant charging, as well as system controls components selections.
3. Unless otherwise noted, all fan coil units shall be selected for the following entering air conditions:

    a. Cooling: 72°F Dry-Bulb, 60°F Wet-Bulb
    b. Heating: 68°F Dry-Bulb

4. Product Data: Submit pipe materials and joining methods.
5. Design Criteria: Submit manufacturer's pipe design guidelines and installation instructions.
6. Shops Drawings: Contractor shall submit scaled drawings (¼" = 1') that include the refrigerant pipe layout including pipe sizes, joint construction, hangers and supports to comply with manufacturer's performance requirements and engineer's design criteria.

a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

7. Wiring Diagrams: For power, signal, and control wiring.
8. Piping diagrams showing pipe sizes, riser locations, and total system refrigerant weight (lbs).
9. Manufacturer Review: Documents submitted shall be reviewed by the manufacturer for compliance with their guidelines and installation methods prior to being submitted. A written letter of compliance shall be submitted on the manufacturer's company letterhead.

E. Contractor Requirements

1. System shall be installed only by a contractor that has completed manufacturer authorized installation and service training. The representative shall provide proof of certification for training indicating successful completion within not more than two (2) years prior to system installation. The contractor shall have completed no less than five (5) projects of 50 tons or greater, submit references for each project. This certification shall be included as part of the equipment and/or controls submittals. On-site contractor training is not allowed.

F. Field quality-control reports.

G. Operation and Maintenance Data: Include emergency, operation, and maintenance manuals.

H. Video recording(s) of training session(s).

I. Warranty: Sample of equipment warranty.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Chicago Electric Code, by a qualified testing agency, and marked for intended location and application. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label

B. ASHRAE Compliance:

1. Applicable requirements in ASHRAE/IESNA 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1230.
2. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
3. Applicable requirements in ASHRAE 62.1-latest edition, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

C. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

1.4 COORDINATION

A. Ground-Mounted Heat Pump Units: Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Roof-Mounted Heat Pump Units: Coordinate sizes and locations of equipment supports, concrete bases, and roof penetrations with actual equipment provided.

1.5 WARRANTY

A. The equipment shall be covered by the manufacturer's limited warranty on parts for a period of ten (10) years from the date of startup. 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. Contractor shall additionally provide warranty as follows:

1. Parts and labor: One (1) year from date of Substantial Completion on the entire units and five (5) years on compressors.

1.6 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The design is based on the variable refrigerant flow (VRF) air conditioning systems as manufactured by BASIS OF DESIGN MANUFACTURER.

B. Acceptable Alternate Systems, assuming adherence to contract documents (drawings and specifications) are as follows:

1. Daikin
2. Mitsubishi
3. LG
4. No substitutions

C. Alternate equipment manufacturer shall provide the bidding mechanical contractor a complete equipment package. If an alternate manufacturer is selected, the contractor shall be responsible for all costs related to providing additional piping, accessories, devices, controls, etc. as required for a complete installation of the system. Work as a result of additional equipment, different electrical requirements, alternate control wiring requirements, alternate piping arrangements shall not result in additional costs to the Owner.

D. Electrical, controls, space requirements, piping arrangement,

E. Rapid changeover: System shall allow automatic and alternating mode switching between heating and cooling mode during owner-defined and adjustable ambient temperature ranges. Systems having changeover sequences which might result in more than one hour delay for the desired heating or cooling will not be accepted.

1. .

2.2 AIR-COOLED HEAT PUMPS

A. General: Air-cooled heat pump modules shall be completely factory assembled, piped & wired and run tested at the factory. The casing(s) shall be fabricated of galvanized steel, bonderized and completely finished. Heat pump units shall be of the size and capacity as scheduled on the drawings.

1. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for an equalizing line(s).
2. Heat pump unit shall have a sound rating no higher than 65 dB(A) individually.
3. Refrigerant lines from the heat pump to the indoor components shall be insulated in accordance with manufacturers installation manual or the local energy code whichever is more stringent.
4. The heat pump shall have an accumulator with refrigerant level sensors and controls.
5. The heat pump shall have a high-pressure safety switch, over-current protection, crankcase heater and DC bus protection.
6. Heat pumps located indoors and shall be ducted to the outdoors. The unit shall be capable of continuous operation and provide full heating capacity at the room's designs space temperature.
7. The heat pumps shall have a nominal heating operating down to -4°F ambient temperatures and cooling mode up to 122°F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as "for reference only" are not considered capable of continuous operation and are not acceptable.
8. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Provide hot gas defrost.
9. The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 200% of the condensing unit capacity.
10. Defrost Heating – Heat pump systems shall maintain continuous heating during defrost operation. Reverse cycle (cooling mode) defrost operation shall not be permitted due to the potential reduction in space temperature.

B. Fan: Each heat pump unit module shall be furnished with one direct drive, variable speed propeller type fan.

1. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
2. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

C. Coil: The heat pump heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction. The coil fins shall have a factory applied corrosion resistant

blue-fin finish. Uncoated aluminum coils/fins are not allowed. The coil shall be protected with an integral metal guard.

1. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

D. Compressor: Each heat pump unit module shall be equipped with all inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) are not permitted.

1. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed.
2. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 15%-5% of rated capacity, depending upon unit size. The compressor shall be equipped with an internal thermal overload.
3. Compressors shall be spring mounted to prevent transmission of vibration.
4. 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.

E. Piping: The piping system shall be connected with manufacturer provided engineered joints and headers to ensure correct refrigerant flow and balancing. T-style joints are not acceptable.

F. Refrigerant: Each unit shall be factory charged with R-410A refrigerant. System refrigerant amount shall be no greater than shown on schedule. Contractor shall provide additional refrigerant charge if required.

1. Polyol-ester (POE) oil shall be used in the units. If an alternate oil is used, submit material safety data sheets (MSDS) and comparison of hygroscopic properties with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

G. Electrical: The outdoor unit electrical power shall be as scheduled on the drawings and shall be capable of satisfactory operation within voltage limits.

2.3 WALL MOUNTED DUCTLESS FAN COIL UNITS

A. General: Fan coil units shall be wall mounted and shall have a modulating linear expansion device and a flat front. The indoor fan coil units shall be assembled, wired and run tested in the factory. All casings shall have the same white finish. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard. There shall be a separate back plate which secures the unit firmly to the wall

1. Each unit shall contain piping, electronic modulating linear expansion device, control circuit board and fan motor complete with all wiring. The unit shall have a self- diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Fan: The fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.

1. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
2. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

C. Coil: The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory.

1. A condensate pan and drain shall be provided under the coil. Both refrigerant lines and condensate drain line shall be insulated.

D. Filter: Return air shall be filtered by means of an easily removable, washable filter.

E. Condensate Pump: Each indoor fan coil unit shall be provided with a built-in condensate removal pump. Pump shall be factory wired and piped. If pump is not available by the manufacturer, the contractor shall provide a field installed condensate pump Aspen Mini Lime or equal. Pump unit shall be wired from associated fan coil unit electrical circuit. Furnish line set cover for refrigerant piping, condensate piing, and condensate pump.

F. Electrical: The unit electrical power shall be as scheduled on the drawings. The system shall be capable of satisfactory operation within voltage limits.

2.4 CEILING RECCESSED CASSETTE

A. General:

1. The ceiling cassette shall be a 24” x 24” or 36” x 36” ceiling cassette style indoor unit that recesses into the ceiling with a ceiling grille. The ceiling cassette shall be field configurable for directional air flow patterns per the installation requirements. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:

1. The cabinet shall be space-saving ceiling-recessed cassette.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
3. Each decoration grilles shall be fixed to bottom of cabinet allowing field adjustable two-way, three-way, four-way blow.
4. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space

C. Fan:

1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.

2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of minimum three (3) speed settings, Low, Medium and High. If a proposed alternate manufacture does not meet the specified CFM, on high speed fan, the proposed manufacturer must go to the next fan coil unit size that meets the specified air flow.
4. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
5. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
6. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space.

D. Filter:

1. Return air shall be filtered by means of a long life washable filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.

F. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.

G. Electrical: The unit electrical power shall be as scheduled on the drawings. The system shall be capable of satisfactory operation within voltage limits.

2.5 SUSPENDED DUCTED FAN COIL UNIT

A. General:

1. The ducted fan coil units shall be a ceiling-concealed ducted indoor unit with integral 2” MERV 13 filter box. The indoor fan coil unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

C. Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available. If a proposed alternate manufacture does not meet the specified CFM, on high speed fan, the proposed manufacturer must go to the next fan coil unit size that meets the specified air flow.
2. The unit shall be equipment with automatically adjusting external static pressure logic selectable during commissioning. This logic shall assure specified air flow is being delivered to the space according to as-built duct work static.
3. The airflow rate shall be available in three settings.
4. The fan motor shall be thermally protected.
5. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
6. Fan motor external static pressure range for nominal airflow

D. Filter Box:

1. The unit manufacturer shall provide a shipped loose return air filter box to be rigidly coupled to the ducted fan coil units. The return air shall be filtered by means of a high efficiency disposable MERV 13 filters shall be available.

E. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4” outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with an 18-3/8” lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

F. Electrical: The unit electrical power shall be as scheduled on the drawings. The system shall be capable of satisfactory operation within voltage limits.

2.6 FLOOR MOUNTED FAN COIL UNIT

A. General:

1. The floor-mounted indoor fan coil 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, flare connections, 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.

B. Unit Cabinet:

1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space. This compact design with finished white casing.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
3. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment.

C. Filter:

1. Return air shall be filtered by means of a long-life washable filter.

D. Fan:

1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of minimum three (3) speed settings: Low, Medium, and High. If a proposed alternate manufacture does not meet the specified CFM, on high speed fan, the proposed manufacturer must go to the next fan coil unit size that meets the specified air flow.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.

F. Electrical: The unit electrical power shall be as scheduled on the drawings. The system shall be capable of satisfactory operation within voltage limits.

2.7 CONTROLS

A. General: Provide manufacturer packaged master central controller (with touch-screen graphical interface) capable of supporting remote controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems via BACnet.

1. The outdoor unit shall be controlled by integral microprocessors. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual indoor units (to accommodate instances when compensation is not required).

a. Provide a complete control package that shall consists of Centralized Controller, Expansion Controller and Advanced HVAC Controllers with instructions & wiring diagrams. These must be capable to supporting all the controllers in the project. Control power shall be provided by an integrated 100-240 VAC power supply.

3. The Controllers shall support system configuration, daily/weekly scheduling, monitoring of operation status, free contact interlock configuration and malfunction monitoring. Centralized Controller shall have basic operation control authority which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation); this basic set of operation controls for the Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (heat recovery systems only), dry, and fan), temperature setting, fan speed setting, and airflow direction setting.
4. Controllers shall be able to enable or disable operation of local remote controllers. Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.
5. Controllers shall be capable of performing/changing initial settings via the panels on the controllers themselves or via a PC browser using the initial settings. Include standard software functions for the building manager to securely log into each central controller via the pc's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics.

B. Additional software function for tenant billing shall be included. The tenant billing function shall require specialized integrated system software in conjunction with the centralized controllers. Tenant billing "charge" calculates per tenant energy usage in kwh and uses user inputs monetary amount based on the energy consumption of the outdoor unit(s) divided among the associated indoor units requires software on local monitoring PC (PC furnished by owner) connected to a local electric meter. Furnish watt hour meters as required for the intended electrical panel configuration and layout.

C. Additional software function for heat pump systems. Provide voting system that allows heat pump system to alternate between heating and cooling to satisfy the demand of heating and cooling in different zones.

D. Indoor Unit Remote Controllers: Backlit, wall-mount remote controllers shall be provided for each indoor unit. Controller shall be compact in size (approximately 3" x 5"), display temperature selection in Fahrenheit or Celsius, and allow the user to change temperature setting, and fan speed setting and airflow direction. Controller must be capable of sensing room temperature. The Backlit Remote Controller shall display a four-digit error code in the event of system abnormality/error.

E. Each indoor unit shall be able to provide set temperature independently via a local remote controller, an Intelligent Manager Controller

F. Wiring: The controls network shall operate at 24-30VDC. Controller power and communications shall be via a common non-polar communications bus. Control wiring shall be installed in a daisy chain configuration from indoor air conditioning units, to the condensing units and to the controllers. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit. Wiring shall be 2-conductor (16

AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output. Network wiring shall be CAT-5 with RJ-45 connection.

G. (

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb. Install ground-mounted, compressor-condenser components on 4-inches thick, reinforced concrete base that is 4 inches larger, on each side, than unit, with cast-in anchor-bolt inserts. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-In-Place Concrete."

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install and connect pre-charged refrigerant pipes to component's quick-connect fittings. Install pipes to allow access to unit.

D. Provide ductwork between condensing units and exhaust louvers. Refer to drawings for size of ductwork.

E. Provide manual shutoff valves at each fan coil unit.

3.2 PIPE CONNECTIONS

A. Follow manufacturer’s recommendations for piping installation. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Piping to use nitrogen purge.

C. Pipe installations shall allow space for service and maintenance of system components.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service Pre-Installation Meeting

1. The VRF manufacturer local representative’s certified VRF field supervisor/project manager shall hold a pre-installation coordination meeting with the mechanical contractor, electrical contractor, BAS contractor and general contractor/construction manager to review the final approved VRF system design submittals, wiring requirements, piping requirements, insulation requirements, project specific installation requirements and all installation procedures
2. The VRF manufacturer local representative’s certified VRF field supervisor/project manager shall visit the project site once per week (minimum) throughout the duration of

the VRF system(s) installation to review contractor compliance with all VRF manufacturer installation requirements

B. Manufacturer's Field Inspections

1. The VRF manufacturer local representative's certified VRF field supervisor/project manager shall visit the project site every two (2) weeks (minimum) throughout the duration of the VRF system(s) installation to review contractor compliance with all VRF manufacturer installation requirements

C. Tests and Inspections:

1. Pressure/Leak Tests: After installation, pressure test system with nitrogen as required by manufacturer installation guidelines.
2. Vacuum Tests: Prior to charging, draw system into vacuum as required by manufacturer installation guidelines.
3. Charging: Refrigerant shall be precisely weighed during charging to ensure the correct system charge as required by the manufacturer.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.4 VRF SYSTEM START-UP AND COMMISSIONING

A. General:
1. The VRF manufacturer local representative's certified VRF field supervisor/project manager shall oversee and assist the installing contractor with the startup and commissioning of VRF equipment as outlined below. This process will be completed in two phases. Phase one shall cover the Pre-Start-Up inspection process, Phase two shall cover the Physical Start-Up & Commissioning of Equipment.
2. All VRF System Commissioning activities shall be completed by an employee of the VRF manufacturer's local rep whose primary job responsibilities are to provide start up and commissioning of their products. Sales staff or in-house support staffs are not permitted to complete this scope of work.
3. A factory certified representative may assist the VRF manufacturer's local representative personnel in the completion of certain elements of work contained within this specification. Activities completed by a Factory Certified Representative shall be supervised onsite by the VRF manufacturer's local representative. Certified representatives shall not be used in lieu of the manufacturer's representative personnel.
4. The installing contractor shall have been certified by the manufacturer to install VRF systems, having attended a minimum 3- day VRF Service & Installation course at an approved training center. A copy of this certificate shall be presented as part of the VRF equipment submittal process.
5. The installing contractor shall assist the VRF manufacturer's local rep in their completion of the system review and have available a technician with appropriate diagnostic tools, materials and equipment, as required, for the duration of the inspection process. The

technician shall be fully licensed and insured to complete necessary duties as directed under the supervision of the VRF manufacturer.

6. The manufacturer's local rep shall record a minimum of 24 hours of system operation. The operation shall be reviewed by the manufacturer's local rep and summary provided in formal summary report included with post start-up documentation.
7. Upon completion of the Equipment Start-Up & VRF Commissioning process, the VRF manufacturer's local rep shall provide a formal report outlining the status of the system, in electronic format only. Contained within this report shall be copies of all field inspection reports, required action items and status, Manufacturers design software As-Built, equipment model & serial numbers.
8. Completion of the Equipment Start-Up and VRF Commissioning process shall verify that the VRF system has been installed per the Engineer's design intent and complies with the VRF manufacturers engineering and installation specifications related to their equipment.
9. Compliance with federal, state and local codes as well as other authorities having jurisdictions are not part of this process and are the responsibility of the installing contractor.

B. Pre Start-Up Inspection:

1. Contractor shall employ the services of the VRF manufacturer's local rep to provide a comprehensive field review of the completed VRF system installation, prior to the physical start up and operation of equipment. Upon satisfaction that the system meets the VRF manufacturer's local rep installation requirements and specifications, the contractor shall be allowed to proceed with the physical start up and operation of equipment.

2. Prior to the pre-start-up inspection, all systems components shall be in a final state of readiness having been fully installed and awaiting inspection.

3. The installing contractor shall provide the VRF manufacturer's local rep a copy of the electronic design file used in the design and engineering process of the system being inspected. This electronic design file shall have been completed on software approved by the specified VRF manufacturer and shall have been updated to reflect as-built conditions.

4. The installing contractor shall have prepared the refrigeration piping systems per equipment installation and service manuals. All refrigerant piping systems, upon completion of assembly, shall have been pressurized to a minimum 600 psi, using dry nitrogen, and held for an uninterrupted 24HR period, with acceptable change due to atmospheric conditions.

    a. A record of the pressure check process shall be recorded and tagged at the outdoor unit. The tag shall contain the following information: date & time of pressure check start, fill pressure, outdoor temperature at start & stop, date & time of pressure check completion, and the person's full name & company information completing the pressure check.

    b. The installing contractor shall engage the General Contractor as a witness of the pressure check process, confirming that all steps and procedures related to the pressure check where properly followed and that the system held the holding pressure of 600PSI for a period of 24hr hours, with acceptable change due to

atmospheric conditions. Witness information, including full name, company name, title,

phone number and signature shall be recorded on same pressure tag used by installing contractor.

5. Upon completion of the 600 psi pressure check, the system shall be evacuated to a level of 500 microns, where it will be held for an uninterrupted 24 hour period with no deflection. The installing contractor shall utilize the triple evacuation method per the equipment install and service manuals.

    a. Evacuation start & stop dates, times, and persons involved shall be recorded and tagged at the outdoor equipment.

    b. Installing contractor shall digitally capture a photo of the micron gauge reading, at the conclusion of the 24 hour holding period, for each system and provide a copy to the VRF manufacturer. Each photo shall contain a tag providing the outdoor units Serial number.

    c. VRF manufacturer local representative's certified VRF field supervisor/project manager shall verify system evacuation tests. Contractor shall provide written acceptance of all evacuation tests from the VRF manufacturer to the Architect/Engineer for review.

6. Upon the completion of the 500-micron hold, the calculated additional refrigerant charge can be added. The calculated refrigerant charge shall have been calculated using the VRF manufacturers design software.

    a. Total refrigerant charge of the system shall be recorded and displayed at the outdoor unit by permanent means.

7. A review of the equipment settings shall be completed, with recommendations provided to improve system performance, if applicable. Physical changes of system settings will be completed by the contractor. Electronic recording of final DIP switches shall be provided as part of the commissioning report.

8. A comprehensive review and visual inspection shall be completed for each piece of equipment following a detailed check list, specific to the equipment being reviewed. A copy of the inspection report shall be provided as part of the manufacturers close out documentation. Any deficiencies found during the inspection process shall be brought to the attention of the installing contractor for corrective action. Any system components that are not accessible for proper inspection shall be noted as such.

9. Indoor Equipment report shall contain the following:

    a. Model & Serial Number
    b. Equipment location
    c. Equipment Tag/Identification number
    d. Network Address & Port Assignment
    e. Digital recording of equipment settings
    f. Mounting/support method
    g. Seismic restraints used
    h. Proper service clearance provided

i. Wiring and connection points are correct
j. High voltage reading(s) within acceptable range
k. Low voltage reading(s) within acceptable range
l. Type of Remote Controller used and its location
m. Occupied space temperature sensing location
n. Air temperature readings within acceptable range
o. Condensate pump interlock method
p. Fan E.S.P. setting
q. Air Filter condition
r. Height differential setting in heat mode
s. Noise level acceptable
t. Refrigerant pipe connected and insulated properly
u. Condensate pipe connected and insulated properly
v. Condition of connected ductwork
w. Fresh air connected
x. Humidifier connected and checked
y. Review of air balance report complete
z. Other interlocked systems, i.e. baseboard heat, booster fan etc.

10. Outdoor Air Cooled equipment report shall contain the following:

a. Model & Serial Number
b. Equipment location
c. Equipment Tag/Identification number
d. Network Address & Port Assignment
e. Digital recording of equipment settings
f. Mounting/support method
g. High Wind Tethering method
h. Proper service clearance provided
i. Defrost Condensate removal addressed
j. Wiring and connection points are correct
k. High voltage reading(s) within acceptable range
l. Low voltage reading(s) within acceptable range
m. Control Network settings
n. Noise level setting
o. Refrigerant pipe installed and insulated properly
p. Low ambient operation settings

11. Physical Start-Up and Commissioning of Equipment:

a. Upon proper equipment start up by the contractor, following the manufacturer's guidelines and specifications, an employee of the VRF manufacturer's local rep shall complete a review of the system performance and complete the following tasks:

1) Check and confirm all communication addressing of system components.
2) Check and confirm each indoor unit, individually, is properly piped and wired by commanding the indoor unit on, in either heat or cool mode and verifying proper response.

3) This process shall be digitally recorded and included as part of the close out documentation.
4) Electronically record a minimum of one-hour of operational data per refrigeration system.
5) Electronically record selector switch positions on all indoor and outdoor equipment.
6) The VRF manufacturer's local rep shall retain the electronically recorded data, collected during the start-up and equipment commissioning process, at a designated location within the US for future reference.

12. Remove and replace malfunctioning units and retest as specified above.

13. Close-Out Information:

a. The VRF manufacturer local representative shall issue a System Performance report at the completion of all fieldwork. Contained within this report shall be an overview of the system performance, recommendations, field reports, all electronic data, and as-built design file.

3.5 TRAINING AND DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain unit as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining system components. 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 "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.
3. Schedule training with Owner, through Architect, with at least seven days advance notice.

B. Demonstrate proper operation of equipment to commissioning agent, if one, and designated Owner's personnel. The scope of the demonstration shall include functional performance requirements under local control as well as any commissioning requirements in Division 01 and 23.

C. Video record the training session(s). The manufacturer may submit a standard training video or training CD for review as an alternate to recording of the training session. The standard video must be reviewed and accepted by the Owner and Commissioning Authority, if one, for the alternate to be acceptable.

END OF SECTION

SECTION 23 82 19

FAN-COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fan-coil units and accessories.

1.2 DEFINITIONS

A. EMS: Energy management system.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, fan curves, operating characteristics, furnished specialties, and accessories.

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. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: 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. Ceiling suspension components.
2. Structural members to which fan-coil units 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.

6. Perimeter moldings for exposed or partially exposed cabinets.

D. Factory Color Chart: Unit color to be selected from standard factory colors by architect.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, and the City of Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 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.

1.6 COORDINATION

A. For fan coils that penetrate or are supported by the ceiling, 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.

1.7 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. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed.
2. Fan Belts: For belt driven fans, furnish one spare fan belt for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide diffusers by one of the following:

1. Carrier Corporation.
2. International Environmental Corporation.
3. Daikin.
4. YORK International Corporation.

2.2 FAN-COILS

A. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

B. Coil Section Insulation: ½ inch foil covered, closed cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. 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.

C. Main and Auxiliary Drain Pans: Insulated stainless steel formed to slope from all directions to the drain connection as required by ASHRAE 62.

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. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with steel discharge grilles.

3. Stack type 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 standard colors. Return grille shall provide maintenance access to fan-coil unit.
4. Steel recessing flanges for recessing fan-coil units into ceiling or wall.

F. .

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 8 MERV.

H. 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.

I. 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 over current protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware. Provide a heating coil contactor with provisions for low voltage remote “user” switch to enable or disable each stage of heating. User switch shall not disconnect 24V control power to DDC controller.

J. Fan and Motor Board: Removable.

1. Fan: Direct drive, forward curved, double width, centrifugal; directly connected to motor. Painted-steel or aluminum wheels, and aluminum, painted-steel, or galvanized- steel fan scrolls.

2. Motor: Motors shall be 3-speed, single phase, 60 Hz constant-torque ECM motors with means for field adjustment of each speed, .. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.
4. Thermal overload protection: Internal thermal overload protection with automatic reset.

K. Factory, Hydronic Piping Package: ASTM B 88, Type L (ASTM B 88M, Type B) copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

1. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

   a. Length: 24 inches (600 mm).
   b. Minimum Diameter: Equal to fan-coil-unit connection size.

2. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; Polytetrafluoroethylene PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
3. Automatic Flow-Control 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.
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. Wrought-Copper Unions: ASME B16.22.
6. See temperature controls section for control valve specification.
7. Risers (for stack type units): ASTM B 88, Type L (ASTM B 88M, Type B) copper pipe with hose and ball valve for system flushing.

L. Provide toggle type or door-interlocked disconnect switch.

M. Provide fan motor contactor with provisions for local-remote “user” switch to start and stop fan motor. User switch shall not disconnect 24V control power to DDC controller.

N. Control devices and operational sequences are specified in Division 23.

2.3 DUCTED FAN-COIL UNITS

A. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

B. Drain Pans: Stainless steel formed to slope from all directions to the drain connection as required by ASHRAE 62.

C. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

D. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.

1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis with mill-finish, aluminum, double-deflection grille.
2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.

E. Direct-Driven Fans (where scheduled): Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls. Provide speed controller or variable frequency drive.

F. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

1. Motors: PSC motors complying with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

G. Provide PSC (Permanent Split Capacity) Motor.

H. Factory, Hydronic Piping Package: ASTM B 88, Type L (ASTM B 88M, Type B) copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

1. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
   a. Length: 24 inches (600 mm).
   b. Minimum Diameter: Equal to fan-coil-unit connection size.

2. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; Polytetrafluoroethylene (PTFE or TFE) seats; and 600-psig minimum CWP rating and blowout-proof stem.
3. Automatic Flow-Control 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.
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. Wrought-Copper Unions: ASME B16.22.
6. Risers (for stack type units): ASTM B 88, Type L (ASTM B 88M, Type B) copper pipe with hose and ball valve for system flushing.

I. Provide toggle type or door-interlocked disconnect switch.

J. Provide fan motor contactor with provisions for local-remote “user” switch to start and stop fan motor. User switch shall not disconnect 24V control power to DDC controller.

K. Control devices and operational sequence are specified in Division 23.

L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units 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 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. . Vibration isolators are specified in Division 23 Section "Vibration Controls for HVAC."

D. Install new filters in each fan-coil unit within two weeks after preliminary acceptance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 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. Provide factory piping package for hydronic units. Install piping package if shipped loose.
3. Connect piping to fan-coil-unit.
4. Where drawings/details do not indicate piping arrangement, provide:

    a. Hydronic units (per coil): Supply side – isolation valve, y-strainer with blow down valve and hose cap, manual air vent, union, control valve with actuator, union, p&t tap and union coil connection. Return side – isolation valve, p&t, auto flow valve, p&t and manual air vent.
    b. .

5. Connect condensate drain to indirect waste.

    a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical Systems."

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 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 fan coil units. Refer to Division 01 Section "Demonstration and Training."

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining fan coils. 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 01 Section "Operation and Maintenance Data." All required and recommended maintenance will be reviewed as well as operational trouble shooting. Provide a written trouble shooting guide if the IOM does not include one.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.
4. Training will occur in two (2) separate two (2) hour sessions, neither on the same day the UV is started up

B. Demonstrate proper operation of equipment to commissioning agent or designated owners personnel. The scope of the demonstration will include functional performance requirements

under building automation control as well as any commissioning requirements in Division 01 and 23 sections.

END OF SECTION

SECTION 26 05 05

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the limited scope construction materials and methods for application with electrical installations as follows:

1. Miscellaneous materials for support of electrical materials and equipment.
2. Electrical equipment coordination and installation.
3. Common electrical installation requirements.

1.2 DEFINITIONS

A. The following definitions apply to excavation operations:

1.3 SUBMITTALS

A. Shop drawings are not required for material and equipment specified under this Section of the specifications.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with City of Chicago Electrical Code.

C. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code – Steel."

1. Certify that welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metrafex Co.
d. Pipeline Seal and Insulator, Inc.

2.2 MISCELLANEOUS MATERIALS

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

D. Expansion Anchors: Carbon-steel wedge or sleeve type.

E. Toggle Bolts: All-steel springhead type.

F. Powder-Driven Threaded Studs: Heat-treated steel.

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 installation and application of access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 ELECTRICAL EQUIPMENT INSTALLATION

A. Materials and Components: Install level, plumb, and parallel and perpendicular to other building

systems and components, unless otherwise indicated.

B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

C. Right of Way: Give to raceways and piping systems installed at a required slope.

3.3 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor, ceiling and wall assemblies to achieve fire-resistance rating of the assembly. Provide 3M™ Fire Barrier Moldable Putty Pads. MPP+ shall be a one component, ready-to-use, intumescent elastomer capable of expanding a minimum of 3 times at 1000°F. The material shall be thixotropic and shall be applicable to overhead, vertical and horizontal firestops. Under normal conditions, 3M™ Fire Barrier Moldable Putty Pads MPP+ shall be noncorrosive to metal and compatible with synthetic cable jackets. The putty shall be listed by independent test agencies such as UL, Intertek or FM. 3M™ Fire Barrier Moldable Putty Pads MPP+ shall be tested to and pass the criteria of ASTM E 814 (UL 1479) Standard Test Method for Fire Tests of Penetration Firestop

Systems and CAN/ULC S115 Standard Method of Fire Tests of Firestop Systems. 3M™ Fire Barrier Moldable Putty Pads MPP+ meets the requirements of the IBC, NFPA 5000, NEC (NFPA 70), NFPA 101.

3.4 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 Section "Cutting and Patching." In addition to the requirements specified in Division 01, the following requirements apply:

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. Upon written instructions for the Architect, uncover and restore Work to provide for Architect 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 matching materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.5 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

B. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

3.6 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.7 MOUNTING HEIGHTS

A. Mounting heights of electrical items shall be as listed below, unless otherwise specified, or by the Architect/Engineer’s field instructions. Dimensions are above finished floor, unless otherwise indicated. In areas where code requires different mount heights, as in hazardous areas, comply with code requirements.

3.8 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, 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 06

SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition.

B. Telecommunication demolition.

1.2 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Sustainable Design Documentation: Submit certification of removal and appropriate disposal of abandoned cables containing lead stabilizers.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field measurements and circuiting arrangements are as indicated.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Architect/Engineer of Record before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
   1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
   2. PCB- and DEHP-containing lighting ballasts.
   3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

I. Repair adjacent construction and finishes damaged during demolition and extension work.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

A. See Section 01 74 19 - LEED Construction Waste Management and Disposal for additional requirements.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

SECTION 26 05 11

CONDUCTORS AND CABLES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

1.2 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with City of Chicago Electrical Code.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver wire and cables according to NEMA WC26.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

B. Coordinate layout and installation of cables with other contractors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Conductors and Cables

a. American Insulated Wire Corp.; a Leviton Company.
b. General Cable Corporation.
c. Senator Wire & Cable Company.
d. Southwire Company.

2. Connectors and Splices

a. AFC Cable Systems, Inc.
b. Hubbell Power Systems, Inc.
c. O-Z/Gedney; EGS Electrical Group LLC.
d. 3M; Electrical Products Division.
e. Tyco Electronics Corp.

2.2 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70.

B. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, and XHHW.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger. Conductors shall be increased if voltage drop exceeds 3% and conductor length is greater than 100 linear feet. Conduit size shall be increased as required to conform with electrical code.

B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger. Conductors shall be increased if voltage drop exceeds 3% and conductor length is greater than 100 linear feet. Conduit size shall be increased as required to conform with electrical code.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. 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.

B. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

D. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

E. Install wires and cables according to manufacturer's written instructions and NECA's "Standard of Care".

F. Remove existing abandoned wires from raceway before pulling in new conductors.

3.4 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 and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Keep conductor splices to a minimum.

E. Connect conductors to outlets and components as indicated and as instructed by manufacturers.

3.5 CONTRACTOR STARTUP AND REPORTING

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes methods and materials for grounding systems and equipment for electrical.

B. Furnish and install complete grounding and bonding system as shown or as implied in the Contract Documents:

1. Equipment grounding.
2. Wiring device grounding.
3. Panelboard grounding.

C. Furnish and install a complete equipotential ground system for data processing systems in strict conformance with City of Chicago Electrical Code, Section 250.

1.2 DEFINITIONS

A. Equipment Grounding Conductor: (EGC):

1. The conductor that connects the non-current-carrying metal parts of equipment to the grounding electrode conductor or ground bus.

B. Grounding Electrode Conductor: (GEC)

1. The conductor that connects the grounding electrodes to the grounded circuit conductor and/or the equipment grounding conductor.

C. Grounded Circuit Conductor: (GCC)

1. A circuit conductor, usually the neutral that is intentionally connected to ground.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Manufacturer’s Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

C. Comply with UL 467 for grounding and bonding materials and equipment.

D. Comply with City of Chicago Electrical Code.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

1.5 REFERENCES

A. IEEE 1100 - Recommend Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book).

B. TIA-942 – Telecommunications Infrastructure Standard for Data Centers.

PART 2 - PRODUCTS

2.1 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).

2.2 CONDUCTORS

A. Equipment Grounding Conductors: Insulated with green color insulation.

B. Grounding-Electrode Conductors: Stranded cable.

C. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.

D. Insulated Conductors: wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

F. Bonding Straps: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

G. Cable assemblies shall be UL Listed and CSA Certified. 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.

H. Tag all ground conductor terminations at ground bar with gray oval fiber "far-end destination" 145p tags as manufactured by one of the following:

1. Anixter (Bloomington, Illinois) tel. # 309/662-5162 or 800/Anixter part #847755246
2. Marconi (Ohio) tel. # 800/927-2780 part #847755246

I. Ground services may be stamped, engraved, or legibly/neatly handwritten on fiber tag. at ground bar terminations also provide engraved brass "do not disconnect" tags manufactured by:

1. Anixter (manufactured by Flextronics and sold by Anixter) part # p0411719
2. Gus Berthold Electric Company (Chicago Illinois) tel. # 312/243-5767 (blank tags purchased by GBE Co. and stamped)

J. All tags at ground bar terminations shall be secured with 9-ply or 12-ply twine/cord manufactured by Anixter. Tie wraps shall not be used. 9-ply part # 095017, 12-ply part # 224758.

2.3 CONNECTORS

A. All connectors shall be two-hole long barrel (double indent) bolted-type hydraulic copper compression connectors and shall be used for conductors larger than #8 AWG. All compression connectors for cable sizes #1/0 AWG and larger shall employ hex or circumferential type crimps, and shall have an inspection hole between the tongue and barrel. The cable shall be completely inserted into the connector before the crimps are made. Connectors shall be as manufactured by Burndy, type ya "hylug", and only on stranded wire. All solid wire ground connections must be exothermically welded or, if run in the interior, soldered. Provide flame retardant insulating covers. provide Thomas and Betts hard cover type "htc". All compression and mechanical connections shall be coated with the corrosion preventative compound no-ox-id "a", as manufactured by Dearborn Chemical Company

B. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Heavy duty Pipe Clamps: Pipe clamps shall be high copper alloy or cast bronze with silicon bronze threaded fasteners; saddle type designed for the size of conductor indicated or required by Contract Documents.
2. Beam Clamps: Beam clamps shall be compression type; heavy duty bronze construction; provide a minimum of 8 square inches of bonding surface; and designed for copper rope-lay cable.
3. Grounding Bushings: Groundings bushings shall be malleable iron, threaded, with insulated liner and solderless lug.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

E. All buried connections shall be exothermic welds. All exposed mechanical and/or high compression connections shall be treated with a protective, anti-oxidant coating. All exothermic welds to galvanizing surfaces shall be sprayed with galvanizing paint.

F. Pressure Connectors: High –conductivity plated units.

G. Terminating Lugs:

1. Exothermic weld or crimp compression type.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

1. Size: ¾ inch by 10 feet.

2.5 GROUNDING SYSTEM CONDUIT

1. All grounding system conduit raceways shall be factory painted “GREEN” unless otherwise noted.

PART 3 - EXECUTION

3.1 APPLICATIONS

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

3.3 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.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.3 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Manufacturer’s Qualifications: Company specializing in manufacturing Products specified in this Section with minimum three years experience.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled:

1. Listing and labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” as defined in OSHA Regulation 1910.7.

D. Comply with City of Chicago Electrical Code.

1.4 DELIVERY, STORAGE AND HANDLING

A. Material delivered to jobsite shall be stored in original packaging per manufacturer’s requirements.

1.5 COORDINATION

A. Provide steel supports, anchor bolts, inserts, etc., for all equipment specified under this section of the specifications.

B. Floor-mounted electrical equipment shall be installed on a minimum of 4 inch concrete housekeeping pads with a minimum of 4 inch equipment inset on all sides. Concrete shall be in accordance with referenced concrete specification section.

C. Provide formed steel support channels extending from and solidly anchored to the floor and ceiling slabs and mount the designated equipment thereto.

D. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.6 PROVIDE CONCRETE PADS FOR:

A. Power Utility Company Transformers and Switchgear as per utility company standards.

B. Switchboards.

C. All floor mounted power distribution panelboards.

1.7 PROVIDE STEEL SUPPORT CHANNELS FOR:

A. Communication and special systems cabinets.

B. Disconnect switches.

C. Fire alarm system cabinets.

D. Individual motor starters and controllers.

E. Individual circuit breakers.

F. Distribution and Panelboards.

1.8 WARRANTY - NOT APPLICABLE

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Steel Slotted Support Systems:

    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.; a division of Cooper Industries.
    c. GS Metals Corp.
    d. Thomas & Betts Corporation.
    e. Unistrut; Tyco International, Ltd.

2. Powder Actuated Fasteners

    a. Hilti Inc.
    b. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    c. MKT Fastening, LLC.
    d. Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

3. Mechanical-expansion Anchors

    a. Cooper B-Line, Inc.; a division of Cooper Industries.
    b. Empire Tool and Manufacturing Co., Inc.
    c. Hilti Inc.
    d. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
    e. MKT Fastening, LLC.

4. Conduit Sealing Bushings:

    a. Bridgeport Fittings, Inc.
    b. Cooper Industries, Inc.
    c. Killark Electric Mfg. Co.
    d. O-Z/Gedney
    e. Raco, Inc.
    f. Spring City Electrical Mfg. Co.

5. Vibration Isolators:

    a. California Dynamics Company
    b. Mason Industries

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Products for outdoor use shall be hot-dip galvanized after fabrication and applied according to MFMA-4.
2. Other supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

2.3 MANUFACTURERD SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps as described in NECA 1 and NECA 101.

B. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

C. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs shall have number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish. Provide OZ/Gedney type “S” cable support or equal.

D. U-Channel Systems: 12-gauge steel channels, with 9/16 inch diameter holes, at a minimum of 2 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-heat-treated steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. 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 in which used.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.4 VIBRATION ISOLATORS

A. General: Provide vibration isolators with either known un-deflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

1. Provide isolators that operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves from the manufacturer that are linear, over a deflection range 50% above the design deflection.

B. Vibration Isolator Types

1. General Properties:

a. The ratio of lateral to vertical stiffness shall be not less than 0.9 or greater than 1.5.
b. The theoretical vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than (+/-) 10%.
c. Wave motion through the isolator shall be reduced to the following extent: Isolation above the primary vertical system resonance frequency shall follow the theoretically predicted isolation curve for single degree of freedom systems with 1- dB to 50 dB at all frequencies above the 150 Hz.
d. All neoprene mountings shall have a shore hardness of 40 –65 after minimum aging of 30 days, or corresponding open-aging.

2. Isolator Description:

    a. Type MS shall be spring type, without housings or snubbers, equipped with leveling bolts and with two layers of ribbed or waffled neoprene pads, separated by a 1/16" galvanized steel plate under the base plate. Neoprene sleeves and washer shall be installed at all anchor bolts.
    b. Type HS shall be suspension hangers having a steel frame and spring element, in series with a neoprene pad, cut or washer. The isolator shall be designed so that hanger rod may be misaligned 15 degrees in any direction relative to the vertical, without contacting hanger box frame.
    c. Type MN shall be neoprene isolator support type unit having a minimum static deflection of ¼".
    d. Type HN shall be a suspension hanger type employing a neoprene isolator unit having a minimum static deflection of ¼".

C. Equipment Frames

1. Mounting frames and brackets shall be provided to carry the load of the equipment without causing mechanical distortion or stress to the equipment.
2. The mounting frames shall consist of welded, wide flange or channel structural steel, with welder brackets to accept the isolators. The section depth of any frame member shall be not less than 1/10th of the length of the longest frame member, and not less than 1/10th of the greatest span between support points. All frame members shall have the same depth.

2.5 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:

    a. 3 inch and smaller: 2 gauge.
    b. 4 inch to 6 inch: 16 gauge.
    c. Over 6 inch: 14 gauge.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in Table 1 at the end of this Section. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 single-bolt conduit clamps using spring friction action for retention in support channel.

D. 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.

E. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

F. Dry Locations: Steel materials.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1, NECA 101 and manufacturer’s instructions for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, RMC EMT, IMC, and RMC may be supported by openings through structure members, as permitted in the Chicago Electrical Code.

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 lb.

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.

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. 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.
9. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
10. Fasteners: Select so the load applied to each fastener does not of its proof test load.
11. Holes cut to depth of more than 1-1/2" in reinforced concrete beams or to depth of more than ¾ inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
12. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration and shock-resistant fasteners for attachments to concrete slabs.

E. Vibration Isolators:

1. All floor supported transformers in excess of 300 kVA located within the building shall be mounted on isolation units utilizing type MS springs, appropriately secured to the transformer housing. Spring units shall be selected for a minimum static deflection of 1.5 inch.
2. All floor supported transformers equal to or less than 300 kVA located within the building shall be mounted on vibration isolation rails utilizing type MN neoprene mounts selected to deflect a minimum of 0.25 inch.
3. Suspended transformers 45 kVA and less shall be supported on an appropriate steel frame from Type HS hangers, selected for a minimum static deflection of 0.75 inch.

3.3 INSTALLATION

A. Where equipment supports are on concrete construction, take care not to weaken concrete or penetrate waterproofing.

B. Obtain prior approval for installation method of structural steel required to frame into building structural members for the support of equipment, conduit, etc. Welding shall be permitted only when approved by Architect.

C. Coordinate dimensions of concrete housekeeping pads with requirements for equipment supplied.

D. Install supporting devices to fasten electric components securely and permanently in accordance with CEC requirements.

E. Coordinate with the building structural system and with other electrical installation.

F. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

G. Raceway Supports: Comply with the CEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
3. Support parallel runs of horizontal raceways together on trapeze-type hangers.
4. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use ¼ inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
5. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with CEC.

H. Vertical Conductors Supports: Install simultaneously with installation of conductors.

I. Do not fasten supports to pipes, ducts, mechanical equipment and conduit.

J. Do not use ceiling system components for support.

K. Provide weight-distributing facilities, where required, so as not to exceed the load-bearing capabilities of floors or walls that bear the weight of, or support, electrical systems.

L. Exposed part of hangers and supports shall be painted with one coat of rust-inhibiting primer.

M. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.

N. Miscellaneous Supports: Support miscellaneous electrical components as required to provide the same structural safety factors as specified for raceway supports. Install metal channel or angle iron racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

O. In overhead spaces, boxes shall be supported independently of raceways. Support boxes directly from the building structure or by bar hangers. Where bar hangers are used for boxes, attach the bar to raceways on opposite side of the box and support the raceway with an approved type of fasteners not more than 2 inches from the box.

P. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls fro raceways can cable installations. For sleeves through fire-rated wall or floor construction, see Division 8 Section "Firestopping" for appropriate UL listed firestopping system.

Q. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

R. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs or nails driven by a power charge may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.

    a. Field Welding: Comply with AWS D1.1.

7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load or the manufacturer's published allowable load capacity. For electrical cable or premises wire hangers for communications. Select nail, screw, or anchor suitable for base material. Space hangers according to cable bundle weight and sagging requirements.
10. Holes cut to depth of more than 1-1/2" in reinforced concrete beams or to depth of more than ¾ inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
11. Use vibration and shock-resistant anchors for vibratory equipment or support attachments to concrete slabs.

S. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

B. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.

C. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

D. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 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 Division 3 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

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.

3.6 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 minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 Section "Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 CLEANING

A. The Contractor shall at all times, keep the site free from accumulations of waste material or rubbish caused by its employees or work. Remove all crates, cartons, and other waste materials or trash from the working areas at the end of each working day. Flammable waste material must be removed from the working areas at the time of generation. Al rubbish and debris, combustible or not, shall be discarded in covered metal containers daily and removed from the premises at least weekly and legally disposed of.

B. The Contractor shall be responsible for the general cleaning and maintenance of the premises and for the coordination and direction of the cleanup work of all trades. Each trade shall clean and maintain its portion of the work as required and as directed by the General Contractor. In case of a dispute, the Owner may remove rubbish and charge the Contractor as shall be determined to be just.

C. Clean all electronic equipment per manufacturer’s requirements as it relates to the project.

D. Clean interior and exterior of concentrator enclosures.

E. All equipment shall be cleaned prior to final acceptance.

3.8 SCHEDULES

TABLE I: SPACING FOR RACEWAY SUPPORTS

Raceway Size (Inches)	No. of Conductors in Run	Maximum Spacing of Supports (Feet)

TABLE I: SPACING FOR RACEWAY SUPPORTS

Raceway Size (Inches)	No. of Conductors in Run		Maximum Spacing of Supports (Feet)	
			RGS & IMC*	EMT
Horizontal Runs				
½, ¾	1 or 2	Flat ceiling or wall.	5	5
½, ¾	1 or 2	Where it's difficult to provide support except at intervals fixed by the building construction.	7	7
½, ¾	3 or more	Any location.	7	7
½ - 1	3 or more	Any location.	7	7
1 & larger	1 or 2	Flat ceiling or wall.	6	6
1 & larger	1 or 2	Where it is difficult to provide support except as intervals fixed by the building construction.	10	10
1 & larger	3 or more	Any location.	10	10
Any	--	Concealed.	10	10
Vertical Runs				
½, ¾	--	Exposed	7	7
1, 1 ¼	--	Exposed	8	8
1 ½ and larger	--	Exposed	10	10
Up to 2	--	Shaftway	14	10
2 ½	--	Shaftway	16	10
3 & larger	--	Shaftway	20	10
Any	--	Concealed	10	10

* Maximum spacings for IMC above apply to straight runs only. Otherwise the maximums for EMT apply.

Abbreviations:

EMT	Electrical metallic tubing.
IMC	Intermediate metallic conduit.
RGS	Rigid galvanized steel conduit.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquid-tight flexible metal conduit.

F. RNC: Rigid nonmetallic conduit.

1.3 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, details, and attachments to other work.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.

1. The Terms “Listed and Labeled”: As defined in City of Chicago Electrical Code.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NECA's "Standard of Installation."

C. Comply with City of Chicago Electrical Code.

1.5 DELIVERY, STORAGE AND HANDLING – NOT APPLICABLE

A. Effectively protect all materials, accessories, and components form any damage or injury from the time of fabrication until final Owner acceptance.

B. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

C. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

1.6 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Metal Conduit and Tubing

    a. Allied Tube & Conduit; a Tyco International Ltd. Co.
    b. Maverick Tube Corporation.
    c. O-Z Gedney; a unit of General Signal.
    d. Wheatland Tube Company.

2. Nonmetallic Conduit

    a. CertainTeed Corp.; Pipe & Plastics Group.
    b. Electri-Flex Co.
    c. RACO; a Hubbell Company.

3. Metal Wireways

    a. Cooper B-Line, Inc.
    b. Hoffman.
    c. Square D; Schneider Electric

4. Boxes, Enclosures, and Cabinets

    a. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
    b. EGS/Appleton Electric.
    c. Hoffman.
    d. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
    e. O-Z/Gedney; a unit of General Signal.
    f. RACO; a Hubbell Company.
    g. Walker Systems, Inc.; Wiremold Company (The).

h. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

2.2 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. IMC: ANSI C80.6.

C. EMT: ANSI C80.3.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquid-tight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: compression type with insulated throat.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

G. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.3 NONMETALLIC CONDUIT

A. RNC: NEMA TC 2, unless otherwise indicated.

B. LFNC: UL 1660.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

D. Fittings for LFNC: UL 514B.

2.4 METAL WIREWAYS

A. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

B. Fittings and Accessories: Include 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.

C. Wireway Covers: Screw-cover type.

D. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways and associated backboxes and coverplates: Galvanized steel with snap-on covers. Manufacturer's standard enamel color coded finish for each system type as follows:

1. Lighting and power receptacle circuits – Natural metallic enamel finish.
2. Grounding system – Green.
3. Fire alarm system – Red.
4. Low voltage (voice, data, signal, temperature control) system – Blue
5. Isolated ground system – Orange.
6. Video surveillance Security and access control systems – Yellow

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Metal Floor Boxes: Cast metal, fully adjustable rectangular.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: IMC.
2. Concealed Conduit, IMC.
3. Underground Conduit: RNC, Type EPC 80-PVC, encased in concrete.
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 3Ror4.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. 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.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install raceways level and square and at proper elevations. Insure adequate headroom.

F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

H. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

I. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by the City of Chicago Electrical Code.

J. Use temporary closures to prevent foreign matter from entering raceways.

K. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

L. Use raceway fittings compatible with raceways and suitable for use and location.

M. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.
2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

N. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

O. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

P. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

Q. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

R. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-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 at the following points:

1. Where conduits pass from warm to cold locations, such as the boundaries of refrigerated spaces.
2. Where otherwise required by CCBC.

S. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.

T. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi- recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

U. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying the raceways to receptacle or fixture ground terminals.

1. Select each surface raceway outlet box, to which a lighting fixture is attached, of sufficient diameter to provide a seat for the fixture canopy.

2. Where a surface raceway is used to supply a lighting fixture having central-stem suspension with a backplate and a canopy (with or without extension ring), no separate outlet box is required.
3. Provide surface metal raceway outlet box, and the backplate and canopy, at the feed-in location of each lighting fixture having end-stem suspension.

3.3 CLEANING

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Preliminary Acceptance.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Preliminary Acceptance.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 33.23

SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Surface raceway systems.

B. Wireways.

1.2 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NFPA 70 - National Electrical Code; 2017.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

E. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.

F. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.

G. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate rough-in locations of outlet boxes provided under Section 26 05 33.16 - Boxes for Electrical Systems and conduit provided under Section 26 05 33.13 - Conduit for Electrical Systems as required for installation of raceways provided under this section.
3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
4. Wall Duct: Coordinate the work with other trades to provide walls suitable for installation of flush-mounted wall duct where indicated.
5. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install raceways until final surface finishes and painting are complete.
2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
   1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

C. Shop Drawings:
   1. Wireways: Provide dimensioned plan and elevation views including adjacent equipment with all required clearances indicated.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 QUALITY ASSURANCE

A. Comply with the Chicago Electrical Code.

B. Product Listing Organization Qualifications: An organization recognized by OSHA Regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 RACEWAY REQUIREMENTS

A. Provide all components, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Do not use raceways for applications other than as permitted by the City of Chicago Electrical Code and product listing.

2.2 SURFACE RACEWAY SYSTEMS

A. Manufacturers:
   1. Hubbell Incorporated: www.hubbell-wiring.com.
   2. Wiremold, a brand of Legrand North America, Inc.: www.legrand.us.

B. Surface Metal Raceways: Listed and labeled as complying with UL 5.
   1. Galvanized steel with snap-on cover.

2. Manufacturer's standard enamel finish in color selected by the Architect/Engineer of Record.

C. Multi-outlet Assemblies: Listed and labeled as complying with UL 111.

2.3 WIREWAYS

A. Manufacturers:
1. Cooper B-Line, a division of Cooper Industries: www.cooperindustries.com.
2. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com.
3. Schneider Electric; Square D Products: www.schneider-electric.us.

B. Description: Lay-in wireways and wiring troughs with removable covers; listed and labeled as complying with UL 870.

C. Wireway Type, Unless Otherwise Indicated:
1. Indoor Clean, Dry Locations: NEMA 250, Type 1, painted steel with screw-cover.
2. Outdoor Locations: NEMA 250, Type 3R, painted steel with screw-cover; include provision for padlocking.
3. Hazardous Locations: NEMA 250, Type 12, painted steal with screw-cover. Sealed and gasketed..

D. Finish for Painted Steel Wireways: Manufacturer's standard enamel finish unless otherwise indicated.

E. Where wireway size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.

2.4 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with the City of Chicago Electrical Code to accommodate raceways.

C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install raceways plumb and level.

D. Arrange wireways and associated raceway connections to comply with the City of Chicago Electrical Code, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.

E. Secure and support raceways in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems at intervals complying with the City of Chicago Electrical Code.

F. Close unused raceway openings.

G. Provide grounding and bonding in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.

H. Identify raceways in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect raceways for damage and defects.

C. Correct wiring deficiencies and replace damaged or defective raceways.

3.4 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 PROTECTION

A. Protect installed raceways from subsequent construction operations.

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 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.

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 **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. Configuration: Units shall be designed for flush burial and have **open** bottom as indicated.

G. 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.

H. 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.

I. 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.

J. 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 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 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: **Type EPC-40 PVC RNC**, 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.

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 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 05 26 “Grounding and Bonding for Electrical Systems”.

3.8 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.

3.9 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 SUMMARY

A. Section includes the following:

1. Identification for raceway.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.2 DEFINITIONS

A. ANSI – American National Standards Institute.

B. UL – Underwriter’s Laboratories.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with the City of Chicago Electrical Code.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

1.6 REFERENCES

A. American National Standards Institute (ANSI): ANSI A 13.1 – Identification of Piping Systems.

B. Manufacturer's catalogs: Specification manufacturers' catalogs are incorporated by reference to same force and effect as if repeated herein in full.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Equipment Identification Plates:

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.

2.2 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.

2.3 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.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.5 WARNING LABELS AND SIGNS

A. Comply with the City of Chicago Electrical Code and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

E. Warning label and sign 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."

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Permanent adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. 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 APPLICATION

A. 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.

B. 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.

C. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

D. 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.

E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. 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.

2. Equipment Requiring Workspace Clearance According to the City of Chicago Electrical Code: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

G. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: 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.

H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label with non-corroding screws.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Access doors and panels for concealed electrical items.
c. Electrical switchgear and switchboards.
d. Transformers.
e. Emergency system boxes and enclosures.
f. Disconnect switches.
g. Enclosed circuit breakers.
h. Motor starters.
i. Push-button stations.
j. Power transfer equipment.
k. Contactors.
l. Battery inverter units.
m. Voice and data cable terminal equipment.
n. Master clock and program equipment.

o. Intercommunication and call system master and staff stations.
p. Television/audio components, racks, and controls.
q. Fire-alarm control panel and annunciators.
r. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
s. Monitoring and control equipment.
t. Uninterruptible power supply equipment.
u. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands 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.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the 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.
    d. Neutral – White.
    e. Ground – Green.

3. Colors for 277/480V, 3 Phase Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Neutral – Gray.
    e. Ground – Green.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

J. Painted Identification: Prepare surface and apply paint according to Division 09 Section "Painting."

K. Provide on device plates for local toggle switches, toggle switch type manual starters, pilot lights, and other electrical items, whose function is not readily apparent, engraved suitable inscriptions or plastic laminate nameplates describing the equipment controlled or indicated.

L. For exterior installations, conduits, except branch lighting circuit conduits, shall be tagged at the ends and in intermediate boxes, chambers, manholes, handholes, and other enclosures in accordance with the same inscriptions as shown on the Drawings.

M. In each switchboard room, electrical closet, or other space containing electrical equipment, provide a vitreous enameled metal sign, red on white, reading “Electrical Equipment Room – No Storage Permitted”. Signs shall be mounted a clearly visible locations within the rooms or on the inside of doors where wall space within the room is not available.

N. In main switchboard rooms install a framed behind-glass blackline print of the feeder diagram complete with the feeder schedules. The print shall be made from an updated an neatly prepared mylar drawing, which includes the field record information. Lettering shall not be smaller than 1/8 inch.

3.3 PATHWAY IDENTIFICATION

A. Conduit labels shall be made adhesive and a minimum of ¾ inch wide, embossed with the designations in 5/16-inch high letters (numbers placed in 2 locations for all spaces and on all pathways at both ends) and legibly written with a permanent marker.

B. Minimum of two (2) labels, one at each end of the pathway and any exposed points (i.e., screw cover boxes, pull points, etc.).

C. Exposed raceways do not need to be labeled unless transitioning into or out of an inaccessible space. When necessary, raceway designation will be (RW).

D. All pathways shall be identified with an alphanumeric identifier to designate locations for the origin and the end of the pathway.

E. Pathways shall follow the hierarchy.

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. Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study performed by a licensed professional engineer hired by the electrical contractor. The contractor shall provide preliminary and post-construction fault-current and overcurrent protective device coordination studies.

B. Section includes computer-based arc flash hazard analysis study. Recommendations for reducing Arc Flash Incident Energy levels and enhancing worker safety shall be issued based on the results of the study. The contractor shall provide preliminary and post-construction arc flash hazard analysis studies.

C. 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.

D. 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 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

M. IEEE C37.010 Guide for AC High-Voltage Circuit Breakers >1000 Vac Rated on a Symmetrical Current Basis

N. IEEE C37.010 Guide for AC High-Voltage Circuit Breakers >1000 Vac Rated on a Symmetrical Current Basis

O. IEEE 1015 Recommended Practice for Applying Low Voltage Circuit Breakers Used in Industrial and Commercial Power Systems

P. IEEE C37.20.01 Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear

Q. IEEE C37.46 Specifications for High-Voltage (>1000 V) Expulsion and Current-Limiting Power Class Fuses and Fuse Disconnecting Switches

R. IEEE 620 Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines

S. 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

T. 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)

U. NETA International Electrical Testing Association

V. NICET National Institute for Certification in Engineering Technologies

W. NEMA MG1 Motors and Generators

X. ICEA P-32-382 Short Circuit Characteristics of Insulated Cable

Y. 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. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.

G. 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 05 83

WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment.

1.2 REFERENCE STANDARDS

A. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

B. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2015).

C. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.

D. NFPA 70 - National Electrical Code; 2017.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
2. Determine connection locations and requirements.
3. Review with all other trades and equipment installers all connection requirements prior to initiation of work.

B. Sequencing:
1. Install rough-in of electrical connections before installation of equipment is required.
2. Make electrical connections before required start-up of equipment.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 QUALITY ASSURANCE

A. Confirm to requirements of Chicago Electrical Code.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Disconnect Switches: As specified in Section 26 28 16.16 - Enclosed Switches and in individual equipment sections.

C. Wiring Devices: As specified in Section 26 27 26 - Wiring Devices

D. Flexible Conduit: As specified in Section 26 05 33.13 - Conduit for Electrical Systems.

E. Wire and Cable: As specified in Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

F. Boxes: As specified in Section 26 05 33.16 - Boxes for Electrical Systems.

2.2 EQUIPMENT CONNECTIONS

A. Equipment connections are as indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

C. Provide receptacle outlet to accommodate connection with attachment plug.

D. Provide cord and cap where field-supplied attachment plug is required.

E. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

F. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 09 19

ENCLOSED CONTACTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General purpose contactors.

B. Lighting contactors.

1.2 REFERENCE STANDARDS

A. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2017.

B. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000, with Errata (2008).

D. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2017.

E. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (Reaffirmed 2016).

F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

H. UL 508 - Industrial Control Equipment; Underwriters Laboratories Inc; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide dimensions, size, voltage ratings and current ratings.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 50 miles of Project.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

C. Listed and labeled as defined in the Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with the City of Chicago Building Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Allen-Bradley/Rockwell Automation: ab.rockwellautomation.com.

B. Eaton Corporation: www.eaton.com.

C. General Electric Company: www.geindustrial.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

E. ASCO Power Technologies, LP; a division of Emerson Electric Company; www.emerson.com.

2.2 GENERAL PURPOSE CONTACTORS

A. Description: NEMA ICS 2, AC general purpose magnetic contactor.

B. Coil operating voltage: 120 volts, 60 Hertz.

C. Poles: As required to match circuit configuration and control function.

D. Enclosure: NEMA ICS 6, Type 1.

E. Accessories:
1. Pushbutton: ON/OFF.
2. Selector Switch: ON/OFF.
3. Indicating Light: RED.
4. Auxiliary Contacts: One, normally open.

2.3 LIGHTING CONTACTORS

A. Description: NEMA ICS 2 and UL 508, magnetic lighting contactor.

B. Configuration: Electrically operated, mechanically held, refer to drawings for required type of controls.

C. Coil operating voltage: 120 volts, 60 Hertz.

D. Poles: As required to match circuit configuration and control function.

E. Contact Rating: Match branch circuit overcurrent protection, considering derating for continuous loads.

F. Enclosure: NEMA ICS 6, Type 1.

G. Accessories:
1. Pushbutton: ON/OFF.
2. Selector Switch: ON/OFF.
3. Indicating Light: RED.
4. Auxiliary Contacts: One, normally open.

2.4 ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, 2 normally open contacts in addition to seal-in contact.

B. Cover Mounted Pilot Devices: NEMA ICS 5, standard type.

C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.

D. Pushbuttons: Unguarded type.

E. Indicating Lights: Transformer, LED type.

F. Selector Switches: Rotary type.

2.5 DISCONNECTS

A. Combination Contactors: Combine contactor with disconnect in common enclosure.

B. Disconnects: Thermal magnetic circuit breaker with integral thermal and instantaneous magnetic trip in each pole; UL listed.

C. Disconnects: Fusible switch assembly; NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate Class R fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosed contactors where indicated, in accordance with manufacturer's instructions.

B. Install enclosed contactors plumb. Provide supports in accordance with Section 26 05 29 - Hangers and Supports for Electrical Systems.

C. Height: 5 ft. to operating handle.

D. Identify enclosed contactors in accordance with Section 26 05 53 - Identification for Electrical Systems.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform applicable inspections and tests listed in NETA ATS, Section 7.16.1.

3.3 CLEANING

A. The contractor shall remove all paint spatters and other spots, dirt and debris from the equipment. Clean equipment internally and externally using methods and materials recommended by the manufacturer.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following lighting control devices:

1. Time clocks.
2. Outdoor and indoor photoelectric switches.
3. Indoor occupancy/vacancy sensors.
4. Outdoor motion sensors.
5. Lighting contactors.

1.2 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Manuals: Provide a collection of manufacturer recommended operation and maintenance practices for each type of product including, but not limited to:

1. Tools required.
2. Acceptable cleaners and recommended cleaning practices.
3. Replacement parts list.
4. Manufacturer service department contact information.
5. Submittal data.
6. Intended operation narrative.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with City of Chicago Building Code.

1.5 DELIVERY, STORAGE AND HANDLING

A. Effectively protect all materials, accessories, and components form any damage or injury from the time of fabrication until final Owner acceptance.

B. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

C. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

1.6 COORDINATION

A. 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 system, and partition assemblies.

1.7 LEED REQUIREMENTS

A. Within 30-days after the date of system acceptance, record drawings of the actual installation shall be provided to the building owner.

B. Implement an independent commissioning authority to review the contractor submittals relative to systems being commissioned.

C. Implement providing the owner with a single manual that contains the information required for re-commissioning building systems.

D. Use a minimum of 20% of lighting control materials that are manufactured regionally within a radius of 500 miles.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Time Clocks

    a. Intermatic, Inc.
    b. Paragon Electrical Products
    c. Tork

2. Outdoor Photoelectric Switches

    a. Intermatic, Inc.
    b. Paragon Electrical Products
    c. Tork
    d. Acuity Controls™ n-Light.

3. Indoor Photoelectric Switches

    a. MicroLite Lighting Control Systems.
    b. Novitas, Inc.
    c. Sensor Switch, Inc.
    d. Watt Stopper (The)
    e. Acuity Controls™ n-Light.

4. Indoor Occupancy/vacancy Sensors

    a. Hubbell Lighting
    b. Leviton Mfg. Company, Inc.
    c. Lutron Electronics, Inc.
    d. Novitas, Inc.
    e. Acuity Controls™ n-Light.

5. Outdoor Motion Sensors

    a. Hubbell Lighting
    b. Leviton Mfg. Company, Inc.
    c. Walt Stopper (The)
    d. Acuity Controls™ n-Light.

6. Lighting Contactors

    a. Leviton
    b. Allen-Bradley/Rockwell Automation.
    c. ASCO Power Technologies, LP; a division of Emerson Electric Co.
    d. Eaton Electrical, Inc.; Cutler-Hammer Products.
    e. GE Industrial Systems; Total Lighting Control.
    f. Square D; Schneider Electric.

2.2 TIME CLOCKS

A. Electronic Time Switches: Electronic seven-day timer with independently programmable SPDT contacts rated for a 20 amp ballast, inductive, tungsten or combination load at a voltage coordinated with the load controlled. The lighting control shall allow multiple input voltages of 120/280/240/277. Lighting control shall be UL listed and shall meet all requirements of the Chicago Energy Conservation Code. Features shall include the following:

1. 24-hour time-of-day programming.
2. Automatic daylight savings adjustment.
3. Holiday and weekend programming (365 days)
4. Astronomic capability (dusk on/dawn off)
5. A minimum of 5 ON and 5 OFF setpoints.
6. Time indicated on AM/PM format.
7. Manual override to ON and OFF positions.
8. Manual skip to next scheduled event.
9. Battery backup to maintain time and program memory for a minimum of 7 days.
10. Transient protection for up to 6,000 volts.
11. Functions over temperature range of -40°F to 122°F.

12. A non-volatile memory maintains all programmed switching times for the life of the time switch. A factory installed field replaceable lithium battery maintains accurate timekeeping and calendar information for a minimum of 8 years.
13. Each circuit has capability for a low voltage input for remote override.
14. Time Switch includes software for programming by computer and via Ethernet connection.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES

A. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, 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, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 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.

2.4 INDOOR PHOTOELECTRIC SWITCHES

A. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
2. Relay Unit: Dry contacts rated for 20 -A ballast load at 120- and 277-V ac, for 13 -A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA and Class 2 power source as defined by the Chicago Electrical Code.
3. Light-Level Monitoring Range: 10 to 200 fc for lighting control of general interior spaces, 100 to 1000 fc for lighting control of interior spaces with large window areas, including atriums and corridors with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

B. Skylight Photoelectric Sensors: Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight, facing up at skylight; with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.

1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.

2. Relay Unit: Dry contacts rated for 20 -A ballast load at 120- and 277-V ac, for 13 -A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA and Class 2 power source as defined by the Chicago Electrical Code.
3. Light-Level Monitoring Range: 1000 to 10,000 fc, with an adjustment for turn-on and turn-off levels within that range.
4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.5 INDOOR OCCUPANCY/VACANCY SENSORS

A. General:

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes. Where multiple occupancy sensors occur within the same space, connect sensors together to control the lights as a unit.
2. Coordination:

    a. Coordinate sensor load rating to load controlled. Provide any power-packs, relays and control components necessary for a fully functional complete system.
    b. Provide occupancy sensors compatible with high- inrush electronic ballasts, compact fluorescent lamps, LED drivers and low-voltage relay control systems.
    c. For dual-technology sensors, coordinate both technologies within the same sensor to have the same coverage area.

3. Sensitivity: Provide either self-adjusting occupancy sensors or provide all necessary contractor start-up (adjustments and fine tuning) of each occupancy sensor prior to Owner Acceptance.
4. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box. Suitably enclose sensor for return air plenum conditions where applicable.
    b. Protection: Provide a vandal resistant coated-steel wire cage around occupancy sensors used in areas subject to damage or vandalism.
    c. Obstructions: Provide ceiling mounted sensors anywhere there is likely to be permanent or temporary obstructions (i.e., stalls, bookcases, coat racks) that limit the sensor's ability to detect movement.
    d. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

B. PIR Type: Detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.

C. Ultrasonic Type: Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
6. Provide sensors operating at a minimum of 32 kHz and a maximum of 98dB.
7. Locate sensors away from areas with strong air currents such as adjacent to HVAC diffusers.
8. Layout shall account for sensitivity adjustments below maximum and any absorptive materials such as carpeting or material covered partitions.

D. Microphonic Type: Detect occupancy by sensing noise level changes in the space.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
6. Do not use the microphonic sensing technology to initiate an ON sequence.
7. Provide automatic gain control.

2.6 OUTDOOR MOTION SENSORS (PIR)

A. Performance Requirements: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as rain-tight according to UL 773A.

1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

3. Bypass Switch: Override the on function in case of sensor failure.
4. Automatic Light-Level Sensor: Adjustable from 1 to 20 fc; keep lighting off during daylight hours.

B. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

C. Detection Coverage: Up to 35 feet, with a field of view of 180 degrees.

2.7 LIGHTING CONTACTORS

A. Description: Electrically operated and mechanically held, combination type with fusible switch, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. 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.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Conductors and Cables for Electrical Systems." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Provide CAT 5e cable in conduit for low voltage lighting control of all lighting fixtures. Provide power packs, relay control panels, etc. for a complete low voltage lighting control system.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 CLEANING

A. The contractor shall remove all paint spatters and other spots, dirt and debris from the equipment. Clean equipment and devices internally and externally using methods and materials recommended by the manufacturer.

3.7 CONTRACTOR STARTUP AND REPORTING

A. Contractor shall prepare and submit a complete set of record drawings, operation and maintenance data and certificates as outlined in this Section.

B. Install any necessary initial lighting controls settings into the field devices. Coordinate schedules with the Owner so that a complete schedule is available at the time of commissioning. Electrical Contractor shall be responsible for schedule updates until panels are turned over to the Owner. Provide final system programming documents including final operating schedules, wiring documentation and programmable device and system switch operation data.

C. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Training shall last a minimum of 4 hours and at the end of the session, the owner's maintenance personnel shall be thoroughly instructed in the proper operation of the system.

3.8 COMMISSIONING AND DEMONSTRATION

A. After system checkout and adjustment, the contractor shall operate the system for the review of the owner and architect. Necessary adjustments or modifications shall be made as required by the owner or architect.

END OF SECTION

SECTION 26 09 36

MODULAR DIMMING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Manual modular dimming controls.
2. Integrated, multi-preset modular dimming controls.

1.2 DEFINITIONS

A. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.

B. Low Voltage: As defined in the Chicago Electrical Code for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.

C. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.

D. SCR: Silicon-controlled rectifier.

E. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For modular dimming controls; include elevation, dimensions, features, characteristics, ratings, and labels.
2. Device plates, plate color and material.
3. Ballasts and lamp combinations compatible with dimmers.
4. Wiring Diagrams: Power, signal, and control wiring.

B. Qualification Data: For Installer and manufacturer.

C. Operation and Maintenance Data: For fixtures, distribution components, and controls to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data," include the following:

1. Tools Required
2. Acceptable cleaners and recommended cleaning practices
3. Replacement parts list
4. Manufacturer service department contract information/ Qualified Service Agencies
5. Submittal data

6. Operational data
7. Intended Operation Narrative

D. Warranty: Provide complete manufacturers warranty information on all products provided.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 101.

C. Comply with City of Chicago Building Code.

1.5 DELIVERY, STORAGE AND HANDLING

A. Effectively protect all materials, accessories, and components form any damage or injury from the time of fabrication until final Owner acceptance.

B. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

C. Store equipment in spaces with environments controlled within manufacturer’s ambient temperature and humidity tolerances for non-operating equipment.

1.6 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:

1. Division 26 Section "Lighting Control Devices."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Leviton Mfg. Company Inc,
2. Lightolier Controls
3. Lutron Electronics, Inc.

2.2 GENERAL DIMMING DEVICE REQUIREMENTS

A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.

B. Dimmers and Dimmer Modules: Comply with UL 508.

1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

2.3 MANUAL MODULAR MULTISCENE DIMMING CONTROLS

A. Description: Factory-fabricated equipment providing manual modular dimming control consisting of a wall-box-mounted, master-scene controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in one-, two-, or three- gang wall box under a single wall plate. Each zone station shall be adjustable to indicated number of scenes, which shall be recorded on the zone controller.

B. Operation: Automatically change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.

C. Each manual modular multiscene dimming controller shall include a master control and remote controls.

D. Each zone shall be configurable to control the following:

1. Fluorescent lamps with electronic or magnetic ballasts.
2. Line-voltage Incandescent lamps.
3. Low-voltage incandescent lamps.
4. HID lamps with electronic ballasts.
5. Non-dimmed loads.

E. Memory: Retain preset scenes through power failures for at least seven days.

F. Device Plates: Style, material, and color shall comply with Division 26 Section "Wiring Devices."

G. Master-Scene Controller: Suitable for mounting in a single flush wall box.

1. Switches: Master off, group dim, group bright, and selectors for each scene.
2. LED indicator lights, one associated with each scene switch, and one for the master off switch.

H. Fluorescent Zone Dimmer: Suitable for operating lighting fixtures and ballasts specified in Division 26 Section "Interior Lighting," and arranged to dim number of scenes indicated for the master-scene controller. Scene selection is at the master-scene controller for setting light levels of each zone associated with scene.

1. Switch: Slider style for setting the light level for each scene.
2. LED indicator lights, one associated with each scene.
3. Electrical Rating: 2000 VA, 120 V.

I. Incandescent Zone Dimmer: Suitable for operating incandescent lamps at line-voltage or low-voltage lamps connected to a transformer and arranged to dim number of scenes indicated for the master-scene controller. Line-voltage incandescent lamps will not be combined on the same zone with low-voltage lamps powered through a transformer. Scene selection shall be at the master-scene controller for setting light levels of each zone associated with scene.

1. Switch: Slider style for setting the light level for each scene.
2. LED indicator lights, one associated with each scene.
3. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.

2.4 INTEGRATED, MULTIPRESET MODULAR DIMMING CONTROLS

A. Description: Factory-fabricated, microprocessor-based, solid-state controls providing manual dimming control consisting of a master station and multiple wall-box, remote-control stations.

B. Operation: Automatically changes variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.

C. Each zone shall be configurable to control the following:

1. Fluorescent lamps with electronic or magnetic ballasts.
2. Line-voltage Incandescent lamps.
3. Low-voltage incandescent lamps.
4. HID lamps with electronic ballasts.
5. Non-dimmed loads.

D. Memory: Retain preset scenes and fade settings through power failures by retaining physical settings of controls.

E. Master Station:

1. Contains control panel and multiple control and dimmer modules.
2. Controls and commands adjustment of each dimmer-zone setting for each scene change from one preset scene to another.

a. Master zone raises and lowers lighting level.
b. Adjustable fade rate for each scene from 1 to 60 seconds.

3. Rear-illuminated, scene-select buttons.
4. Lighting-level setting and fade-rate setting shall be graphically shown using LEDs or backlighted bar-graph indicator.
5. Mounting: Flush wall box with manufacturer's standard faceplate.

F. Remote-Control Stations:

1. Numbered push buttons to select scenes.
2. Off switch to turn master station off. Operating the off switch at any remote station shall automatically turn on selected night lighting.
3. On switch turns all scenes of master station to full bright.
4. Control Wiring: Chicago Electrical Code, Class 2.

5. Mounting: Single flush wall box with manufacturer's standard faceplate.

G. Infrared Remote-Control Station: Same functions as for standard remote-control station, except that functions are input by a hand-held infrared transmitter.

1. Dimmers: Reference approved dimming ballasts specified in Division 26 Section "Interior Lighting".

2.5 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Conductors and Cables for Electrical Systems."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems " for identifying components and power and control wiring.

B. Label each dimmer module with a unique designation.

C. Label each scene control button with approved scene description.

3.3 FIELD QUALITY CONTROL

A. Contractor shall inspect, test, and adjust components, assemblies, and equipment installations, including connections and report results in writing.

B. Tests and Inspections:

1. Continuity tests of circuits.
2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

C. Remove and replace malfunctioning modular dimming control components and retest as specified above.

D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.4 CLEANING

A. The contractor shall remove all paint spatters and other spots, dirt and debris from the equipment. Clean equipment and devices internally and externally using methods and materials recommended by the manufacturer.

3.5 CONTRACTOR STARTUP AND REPORTING

A. Contractor shall prepare and submit a complete set of record drawings, test reports, operation and maintenance data and certificates as outlined in this Section.

B. Train Owner's maintenance personnel to adjust, operate, and maintain modular dimming controls. Training shall last a minimum of 4 hours and at the end of the session, the owner’s maintenance personnel shall be thoroughly instructed in the proper operation of the system.

3.6 COMMISSIONING AND DEMONSTRATION

A. After system checkout and adjustment, the contractor shall operate the system for the review of the owner and architect. Necessary adjustments or modifications shall be made as required by the owner or architect.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Distribution panelboards 600V and less.
2. Lighting and appliance branch-circuit panelboards 600V and less.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of panelboards and overcurrent protective devices.
d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports including the following:

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.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Sections "Closeout Procedures" and "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA PB 1.

E. Comply with the City of Chicago Electrical Code.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F.
2. 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 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 Architect and Owner's representative no fewer than seven working days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Architect's and Owner's representative written permission.

1.6 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, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

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. Keys: Six spares for each type of panelboard cabinet lock.

1.8 DELIVERY, STORAGE AND HANDLING

A. Store enclosed panelboards indoors in clean and dry space with uniform temperature to prevent condensation. Protect panelboards from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover panelboards to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside panelboards; install electric heating of sufficient wattage to prevent condensation.

C. Deliver in factor shipping cartons.

D. Handle panelboards to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a. Eaton Corporation; Cutler-Hammer Products.
b. General Electric Co.; Electrical Distribution & Protection Div.
c. Siemens Energy & Automation, Inc.
d. Square D.

2.2 MANUFACTURED UNITS

A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.

1. Rated for environmental conditions at installed location.

    a. Outdoor Locations: NEMA 250, Type 3R.
    b. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
    c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel s.
5. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
6. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.

B. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
5. Split Bus: Vertical buses divided into individual vertical s.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Compression type.
2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals. Series rated panelboards and branch circuit breakers shall not be acceptable.

2.4 DISTRIBUTION PANELBOARDS

A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
3. Fused switches.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: 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-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. GFCI Circuit Breakers: Single- and two-pole configurations with [**5**] [**30**]-mA trip sensitivity.
5. Provide fixed, thermal magnetic type circuit breaker complete with supervisory relay in the "closed position" and all associated conduit and wiring to the fire alarm system control panel for circuit breakers feeding fire pumps. These circuit breakers shall provide short-circuit protection only as per City of Chicago Electric Code.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage where indicated on drawings..
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
8. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Division 26 Section "Fuses."

2.7 CONTACTORS

A. NEMA ICS 2, Class A, combination controller equipped for panelboard mounting and including the following accessories:

1. Individual control-power transformers.
2. Fuses for control-power transformers.
3. Indicating lights.
4. Seal-in contact.
5. Two convertible auxiliary contacts.
6. Push buttons.
7. Selector switches.

B. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller.

1. Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. Control-Power Source: 120-V branch circuit.

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.

2.9 CIRCUIT MONITORS – FOR PANELBOARD CIRCUIT BREAKERS WHERE INDICATED ON THE DRAWINGS

A. Provide space and voltage taps in each panel with electrical sub-metering equipment.

1. Voltage taps will be designed for 14 to 12 gage wire.
2. To determine space requirements use Veris H8053 with 3 current transformers.
3. The submeter maybe field or factory installed. The Div 15 BAS system installer will provide submeter.

4. If indicated on the drawings, two sets of submeters will be provided. For example, if a panel to be monitored includes both lighting and plug loads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. 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.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 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."

3.4 GROUNDING

A. Make equipment grounding connections for panelboards as indicated.

B. Provide ground continuity to main electrical ground bus as indicated.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 DEMONSTRATION AND TRAINING

A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate Panelboards and OCPD's and train Owner's maintenance personnel.

B. Conduct a minimum of one half day of training in operation and maintenance as specified in Division 01 Section "Closeout Procedures". Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least seven days' advance notice.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 CONTRACTOR STARTUP AND REPORTING

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case 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.

3.9 COMMISSIONING AND DEMONSTRATION

A. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:

1. Perform measurements during period of normal working load as advised by Owner.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Solid-state fan speed controls.
2. Wall-switch.
3. Controlled Receptacles.

1.2 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. UTP: Unshielded twisted pair.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

C. Field quality-control test reports.

1.4 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 in the City of Chicago Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 101.

D. Comply with City of Chicago Electrical Code.

1.5 DELIVERY, STORAGE AND HANDLING

A. Effectively protect all materials, accessories, and components form any damage or injury from the time of fabrication until final Owner acceptance.

B. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

C. Store equipment in spaces with environments controlled within manufacturer's ambient temperature and humidity tolerances for non-operating equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Wiring Devices:

a. Cooper Wiring Devices; a division of Cooper Industries, Inc.
b. Hubbell Incorporated; Wiring Device-Kellems
c. Leviton Mfg. Company Inc.
d. Pass & Seymour/Legrand; Wiring Devices & Accessories

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: "DECORATOR" style. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 and Federal Specification W-C-596. Pre-wired pigtail connectors that accommodate Fed Spec receptacles are approved. Pigtail connectors must be crimped and welded terminal right-angle application connector.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Legrand; PT26352W-TR (duplex – use with PTRA6STRNA prewired pigtail connector).
b. Eaton; TR6352W (duplex).
c. Hubbell; DR20WHITR (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped. Units shall fit in a 2-3/4" deep outlet box without an adapter.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

2.6 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

C. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

2.7 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Continuously adjustable slider, 5 A.
2. Three-speed adjustable slider, 1.5 A.

2.8 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: 0.035-inch thick, satin-finished stainless steel except as noted otherwise on drawings.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.9 FINISHES

A. Color:

1. Wiring Devices Connected to Normal Power System: White, or as directed by the architect and required by Chicago Electrical Code or device listing.
2. Wiring Devices connected to automatic control system (Controlled Receptacles): White, Green or as selected by architect.
3. Wiring Devices Connected to Emergency Power System: Solid Red.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. 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 the 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 so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just 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 meet provisions of Chicago Electrical Code, 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 all devices that have been in temporary use during construction or that show signs that they 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, 2/3 to 3/4 of the way around terminal screw.
6. Modular wiring devices are seen as an acceptable alternative at the discretion of the contractor. Receptacles must meet UL498 and Federal Specification WC-596 requirements. Switches must meet UL20 and Federal Specification WC-896 requirements. Prewired terminal right angle application pigtail connectors must be crimped and welded.
7. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
9. Tighten unused terminal screws on the device.
10. 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. 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.

F. 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.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
3. Test Wiring Devices: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.

B. Tests for Convenience 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 not acceptable.
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. The 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.

C. Replace damaged or defective components.

3.3 CLEANING

A. The contractor shall remove all paint spatters and other spots, dirt and debris from the equipment. Clean equipment and devices internally and externally using methods and materials recommended by the manufacturer. Replace stained or improperly painted wall plates or devices.

3.4 CONTRACTOR STARTUP AND REPORTING

A. Contractor shall prepare and submit a complete set of record drawings, test reports, operation and maintenance data and certificates as outlined in this Section.

3.5 COMMISSIONING AND DEMONSTRATION

A. After system checkout and adjustment, the contractor shall operate the system for the review of the owner and architect. Necessary adjustments or modifications shall be made as required by the owner or architect.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following individually mounted, enclosed switches and circuit breakers rated 600V AC and less:

1. Fusible switches.
2. Nonfusible switches.
3. Bolted-pressure contact switches.
4. Molded-case circuit breakers.
5. Molded-case switches.
6. Enclosures.

1.2 DEFINITIONS

A. GD: General duty.

B. GFCI: Ground-fault circuit interrupter.

C. HD: Heavy duty.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.3 REFERENCES

A. International Electrical Testing Association

1. NETA, ATS – 1999; Electrical Testing Specifications for Electrical Power Distribution Equipment and Systems

B. National Electrical Manufacturers Association

1. NEMA 250-97: Enclosures for Electrical equipment (1000V Maximum)
2. NEMA 1-99: Molded Case Circuit Breakers and Molded Case Switches
3. NEMA FU 1-86: Low Voltage Cartridge Fuses
4. NEMA KS 1-01: Enclosed and Miscellaneous Distribution Equipment Switches (600Volts Maximum)
5. NEMA PB 1.1-96: General Instructions for proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
6. NEMA PB 2.1-96: General Instructions for proper Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less

C. Underwriters Laboratories

1. UL 486A: Wire connectors and soldering lugs for use with copper conductors
2. UL 98: Enclosed and Dead-Front Switches.
3. UL 489: Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
4. UL 977: Fused Power Circuit Devices
5. UL 1053: Ground Fault Sensing and Relaying Equipment

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current rating.
4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
5. Time current curves.
6. Let-through current curves for circuit breakers with current limiting characteristics.
7. Coordination charts, tables and related data.

B. Shop Drawings: Wiring Diagrams detailing power, signal, and control wiring and differentiating between manufacturer-installed and field-installed wiring.

C. Field quality-control test reports including the following:

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.

D. Manufacturer's field service report.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Sections "Closeout Procedures" and “Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with the City of Chicago Electrical Code.

C. 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.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store enclosed switches and circuit breakers indoors in clean and dry space with uniform temperature to prevent condensation. Protect enclosed switches and circuit breakers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed switches and circuit breakers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials. Install electric heating of sufficient wattage to prevent condensation.

C. Deliver in factory shipping cartons.

D. Handle enclosed switches and circuit breakers to avoid damage.

1.7 COMPATIBILITY

A. Protective devices added to existing assemblies shall have compatible interrupting ratings with the existing assembly and shall be of the original manufacturer. If not available, modify or extend the assembly to accept compatible protective devices of same manufacturer as supplied in new assemblies.

1.8 PROJECT 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.

1.9 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.10 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. Spares: For the following:

a. Potential Transformer Fuses: Three of each type installed.
b. Control-Power Fuses: Three of each type installed.

c. Fuses and Fusible Devices for Fused Circuit Breakers: Three of each type installed.
d. Fuses for Fusible Switches: Three of each type installed.

2. Spare Indicating Lights: Three of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control .
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider.
5. Boltswitch,Inc.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Fusible Switch, 600 or 1200 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

B. Nonfusible Switch, 600 or 1200 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two 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; and labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 FUSED POWER CIRCUIT DEVICES

A. Bolted-Pressure Contact Switch: UL 977; operating mechanism shall use a rotary-mechanical-bolting action to produce and maintain high-clamping pressure on the switch blade after it engages the stationary contacts.

1. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
2. Service-Rated Switches: Labeled for use as service equipment.
3. Ground-Fault Relay: Comply with UL 1053. Self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground fault indicator.
b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
c. No-Trip Relay Test: Operation of "no-trip" test control permits ground-fault simulation test without tripping switch.
d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

4. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

2.4 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Molded-Case Circuit Breaker: NEMA AB 1, 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-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I^2t response.

4. GFCI Circuit Breakers: Single- and two-pole configurations with [**5**] [**30**]-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

C. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

D. Molded-Case Switch Accessories:

1. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Test kit for each type of solid state breaker.

4. Handle extensions.

E. Additional accessories:

1. Provide breaker accessories for general operation and maintenance of specified breakers. Include items listed below and items recommended by manufacturer:

a. Handle extensions for devices not mounted in panelboards.
b. Special adjustment tools.

2. Provide quantities of circuit protective accessories in locations necessary for effective general operation.

2.5 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

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.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete materials and installation requirements are specified in Division 03.

3.3 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base. Support enclosures independent from stud partitions.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components. Provide quantities of the circuit protective devices accessories in locations necessary for the effective general operations of the facility.

D. Install new circuit protective devices to existing assemblies when shown on drawings. Rearrange existing circuit protective devices and provide bus extensions, hardware, enclosure modifications, etc., to accomplish the installations. Modify assemblies, directories or add nameplates to match existing.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between OCPDs and control/indication devices as specified in Division 26 Section "Conductors and Cables for Electrical Systems."

3.6 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

B. Adjust operating mechanisms for free mechanical movement.

3.7 DEMONSTRATION

A. Training: Arrange and pay for the services of factory-authorized service representative to demonstrate OCPDs and train Owner’s maintenance personnel.

B. Conduct a minimum of one half day of training in operation and maintenance as specified in the Division 01 Sections “Closeout Procedures” and “Demonstration and Training.” Include both classroom training and hands on equipment operation and maintenance procedures.

C. Schedule training with at least seven days’ advance notification.

3.8 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

3.9 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. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.

3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case 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.

END OF SECTION

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes enclosed controllers rated 600 Vac and less, of the following types:

1. Combination and non-combination motor controllers.
2. Across-the-line, manual and magnetic controllers.
3. Reduced-voltage controllers.
4. Multispeed controllers.

1.2 DEFINITIONS

A. Motor Controller: A device that controls, protects, and energizes an electric motor, and where required, controls its speed or the torque or power delivered by it.

B. Single Phase Starter: Starters for 115VAC single phase motors less than 1 HP shall be capable of both manual and automatic operation.

C. Magnetic Starters: Starters for 3-phase motors shall be magnetic starters.

D. Combination Starters: Provide combination magnetic starters for all motors requiring branch circuit protection or a line-of-sight disconnect.

1.3 REFERENCES

A. International Electrical Testing Association

1. NETA ATS: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems

B. National Electrical Manufacturers Association

1. NEMA 250: Enclosures for Electrical Equipment (1000 volts maximum)
2. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches
3. NEMA ICS 2, 2000: Industrial Control Devices, Controllers and Assemblies
4. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
5. NEMA MGG 1: Motors and Generators (Including Rev.1)
6. IEC 60947-5, 60947-4, 60947-3
7. UL 508, and UL508A Industrial Control Equipment.
8. ANSI/NFPA -70, National Electric Code

1.4 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

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. Include the following:

   a. Each installed unit's type and details.
   b. Nameplate legends.
   c. Short-circuit current rating of integrated unit.
   d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
   e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For manufacturer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Sections "Closeout Procedures" and "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing motor controllers similar to that required for this project.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the City of Chicago Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with the City of Chicago Electrical Code.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

G. Manufacturer shall provide a five year warranty on the complete starter assembly.

H. The starter assembly shall be UL listed under UL 508A.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

C. Deliver in factory shipping cartons.

D. Handle motor controllers to avoid damage.

1.7 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 Architect and owner's representative no fewer than seven days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Architect's and owner's representative written permission.

1.8 COORDINATION

A. Coordinate layout and installation of enclosed controllers 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 size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 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. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Cerus Industrial (Franklin Control Systems)
2. Eaton Corporation; Cutler-Hammer Products.
3. General Electrical Company; GE Industrial Systems.
4. Square D.

2.2 ENCLOSED FULL VOLTAGE NON-REVERSING (FVNR) SINGLE PHASE STARTER

A. Single Phase Motor Starter Control: The single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the “Off” position which shall also function as the motor disconnect. Additionally, the starter shall provide thermal overload protection, run status pilot light and fault pilot light. The starter must include the capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output and fault

output. All control ter

minals shall be integrated in the starter. At a minimum, each single phase starter shall include an interposing run relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure.

B. Approved manufacturer: Cerus Industrial, model BAS-1P or approved equal.

2.3 ENCLOSED FULL VOLTAGE NON-REVERSING (FVNR) NON-COMBINATION STARTER

A. Magnetic Motor Starters shall be enclosed in a general purpose electrical enclosure with the appropriate environmental rating.

B. Starters shall consist of a horsepower rated magnetic contactor with a minimum of 1NO and 1NC auxiliary contacts and solid state electronic overload relay. Overload relay shall protect all three phases with a wide range current setting and trip class to allow field adjustment for specific motor FLA. Interchangeable heater elements are not acceptable. Overload relay shall provide phase failure, phase loss, locked rotor and stall protection.

C. Provide a manual reset pushbutton on the starter cover to restore normal operation after a trip or fault condition.

D. Each starter shall include an installed 50VA control power transformer (CPT) with protected secondary. The CPT must accept the available line voltage and the control voltage shall not exceed 120V.

E. Installed accessories shall include Hand-Off-Auto operation switch with 22mm style operator interfaces. Include LED pilot light indicators for Hand, Off, Auto, Run and Overload conditions. All pilot devices shall be water tight and dust tight.

F. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals including 24VAC, 120VAC, 24VDC and 48VDC to allow direct connection of the transistorized automation signal to the starter.

G. In applications where the motor is interlocked with a damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only close the motor circuit and start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.

H. The starter shall provide a provision for Fireman's Override operation. When activated, the starter run the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or auto. The purpose of the Fireman's Override input is to act as a smoke purge function. Fireman's Override has priority over the Emergency Shutdown input.

I. If the starter is controlled by a fire alarm or life safety system, the starter shall include an Emergency Shutdown input which will disable the starter from operating in either Hand or Auto mode regardless of other inputs either manual or auto.

J. Manufacturer shall provide and install tags with engraved white lettering to designate equipment served.

2.4 ENCLOSED FULL VOLTAGE NON-REVERSING (FVNR) COMBINATION STARTER

A. Enclosed combination starters shall include all of the magnetic starter requirements in addition to a disconnecting method. All disconnects shall include a lock-out mechanism when in the off position.

B. Motor circuit protectors (MCP) shall be provided as the acceptable form of disconnecting means. The MCP shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The MCP shall carry a UL 508F rating (up to 100A frame size) which provides for coordinated short circuit rating for use with the motor contactor and provides a minimum interrupting rating of 30,000 AIC for the combination starter.

2.5 ENCLOSED STARTER OPTIONS

A. Provide over/under voltage and phase monitoring capability. Monitor shall be field adjustable for both over and under voltage levels and a delay time before returning to normal operation after a trip.

B. Starter must measure and display output current on the front cover. If necessary, install digital or analog ammeter.

C. The starter shall provide the capability to monitor and calculate power consumption (kWh) of the motor load. Each starter shall display the calculated kW and kWh. Additionally, provide either a pulse output (kWh) or 4-20mA analog signal (kW) to the automation system to monitor the power consumption.

D. Starter must be capable of communicating over BACnet MS/TP. At a minimum, reported points shall include starter mode, terminal input status, run/fault status, voltage, current, power factor, kW and kWh.

2.6 COMBINATION 2-SPEED MAGNETIC MOTOR CONTROLLERS

A. General: Match controller to motor type, application, to number of speeds, and number of windings. The starter shall serve the purpose of starting a 2-speed motor at the pre-selected speed and to provide complete overload, overcurrent, and under-voltage protection at each speed.

B. NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Auxiliary run contacts with 24v and 120v dual inputs are acceptable.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Adjustable Class 10 or Class 20 tripping characteristics. Provide with Electronic Overload protection in each phase matched to nameplate full-load current of

specific motor to which they connect and with appropriate adjustment to cover a range of 1 to 40 amps.

3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 or Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5. Pilot lights:

    a. Five lights with respective labels to indicate Hand Off and Auto, Motor Running, and Fault, High and Low Status. The 2-speed starter shall be an assembly of two magnetic across-the-line starters, one for each motor speed, mechanically interlocked and wired for automatic control through a cover mounted control switch. Include single phase protection.
    b. Decelerating Relay: Provide selection of lower than current operating speed by push-button or pilot device as indicated with deceleration automatically timed through any intervening speeds.

2.7 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
3. LED indicators showing motor and control status, including the following conditions:

    a. Control power available.
    b. Controller on.
    c. Overload trip.
    d. Loss of phase.
    e. Shorted silicon-controlled rectifier.

4. Automatic voltage-reduction controls to reduce voltage when motor is running at light load.
5. Motor running contactor operating automatically when full voltage is applied to motor.
6. Shorting contactor:

    a. A microprocessor shall control the operation of the shorting contactor via an output relay.
    b. The shorting contactor shall close, shorting the thyristors after the motor current is below 130% of motor FLA and voltage is below nominal voltage (indicating ramp complete), and open on a stop command to allow deceleration ramp.

7. Motor must be automatically protected from solid state component failure by one of the following means:

    a. Shunt trip coil to trip disconnect in the event of a controller fault condition including a shorted thyristor.

b. Isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted thyristor.

2.8 MULTISPEED ENCLOSED CONTROLLERS

A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.9 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.10 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations and Pilot Lights: NEMA ICS 2, heavy-duty type.

C. Hand-Off-Automatic selector switches: NEMA ICS 2, heavy-duty type.

D. Other selector switches as required: NEMA ICS 2, heavy-duty type.

E. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

F. Control Relays: Auxiliary and adjustable time-delay relays.

G. Elapsed Time Meters: Heavy duty with digital readout in hours.

H. Phase-Failure and Under-voltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable under-voltage setting.

2.11 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, available clearances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

D. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

E. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks.

B. Install freestanding equipment on concrete bases.

C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

D. Provide a 120V single-phase, 20 amp branch circuit with 2 #12 & 1 #12 ground in a ¾" conduit from branch panelboard to each gas solenoid valve for each hot water plant system, domestic water plant system and kitchen equipment safety system. Coordinate with BAS (Building Automation System) drawings and installing contractor for exact quantity and location of each solenoid valve.

3.4 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables for Electrical Systems."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 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 Section "Grounding and Bonding for Electrical Systems."

3.7 DEMONSTRATION

A. Training: Engage a factory-authorized service representative to demonstrate solid-state controllers and train Owner's maintenance personnel to adjust, operate and maintain enclosed controllers. Refer to Division 01 Section “Demonstration and Training”.

1. Conduct a minimum of 4 hours of training in operation and maintenance as specified in Division 01 Section "Closeout Procedures." Include training relating to equipment operation and maintenance procedures.
2. Schedule training with at least 7 days' advance notice.

3.8 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 recommended by manufacturer.

3.9 CONTRACTOR STARTUP AND REPORTING

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
2. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, as stated in NETA ATS, "Motor Control - Motor Starters." 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. Pretesting: On completing installation of the system, perform the following preparations for tests:

1. Make insulation resistance tests of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by the manufacturer.
2. Make continuity tests of circuits.
3. Provide set of Contract Documents to test personnel. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
4. Provide manufacturer's instructions for installation and testing of motor control devices to test personnel.

E. Visual and mechanical inspection: Include the following inspections and related work:

1. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final arrangement and parameters. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit load current and overload relay heater list.
2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current project drawings.
3. Exercise and perform operational tests of mechanical components and other devices in accordance with manufacturer's instructions.
4. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer's recommended torque values.
5. Clean devices using manufacturer's approved methods and materials.
6. Verify proper fuse types and ratings in fusible devices.

F. Electrical Tests: Perform the following in accordance with manufacturer's instructions:

1. Insulation resistance test of motor control devices conducting parts to the extent permitted by the manufacturer's instructions. Insulation resistance less than 10 megohms is not acceptable.
2. Use primary current injection to check performance characteristics of motor-circuit protectors and for overload relays of controllers for motors 15 horsepower and larger. Trip characteristics not within manufacturer's published time-current tolerances are not acceptable.
3. Make adjustments for final settings of adjustable-trip devices.

4. Test auxiliary protective features such as loss of phase, phase unbalance and under-voltage to verify operation.
5. Check for improper voltages at terminals in controllers that have external control wiring when controller disconnect is opened.

G. Correct deficiencies and retest motor control devices. Verify by the system tests that specified requirements are met.

H. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION

SECTION 26 29 23

VARIABLE-FREQUENCY 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. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:

1. Division 26 Section "Electrical Power Monitoring and Control" for monitoring and control of motor circuits.
2. Division 26 Section "Surge Protection Devices" for low-voltage power, control, and communication surge suppressors.

1.3 DEFINITIONS

A. BMS: Building management system.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFC: Variable frequency controller.

1.4 SUBMITTALS

A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFC.

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. Include the following:

    a. Each installed unit's type and details.
    b. Nameplate legends.
    c. Short-circuit current rating of integrated unit.
    d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
    e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that VFCs, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For manufacturer and testing agency.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for VFCs and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.

D. 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.

E. Comply with NFPA 70.

F. Comply with Chicago Building Code.

G. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; 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: 0 to 40 deg C.
2. Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.8 COORDINATION

A. Coordinate layout and installation of VFCs 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 size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 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. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Baldor Electric Company (Graham).
3. Danfoss Inc.; Danfoss Electronic Drives Div.
4. Eaton Corporation; Cutler-Hammer Products.
5. General Electric Company; GE Industrial Systems.
6. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
7. Siemens Energy and Automation; Industrial Products Division.
8. Square D.
9. Toshiba International Corporation.

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFC; 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 of 208 V, plus or minus 5 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
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. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.
2. Pneumatic Signal: 3 to 15 psig (20 to 104 kPa).

F. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.

5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class [**10**] [**20**] [**30**] performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor overtemperature fault.

H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

I. Automatic Reset/Restart: Attempts three restarts after controller 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 controller, motor, or load.

J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

K. 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.

L. 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.

M. Provide input Line Conditioning.

N. Provide VFC Output Filtering.

O. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

P. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

Q. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

R. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Pneumatic Input Signal Interface: 3 to 15 psig.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:

    a. 0 to 10-V dc.
    b. 0-20 or 4-20 mA.
    c. Potentiometer using up/down digital inputs.
    d. Fixed frequencies using digital inputs.
    e. RS485.
    f. Keypad display for local hand operation.

4. Output Signal Interface:

    a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hz).
        2) Output current (load).
        3) DC-link voltage (VDC).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hz).

5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

    a. Motor running.
    b. Set-point speed reached.
    c. Fault and warning indication (overtemperature or overcurrent).
    d. PID high- or low-speed limits reached.

S. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be

programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

T. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

U. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across- the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

V. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

W. Isolating Switch: Non-load-break switch arranged to isolate VFC and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

X. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ENCLOSURES

A. Nema 1 where installed indoors.

B. Nema 3R complete with environmental enclosure complete with fan kit and strip heater where installed outdoors exposed to the environment.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).

6. Motor speed (rpm).
7. Motor output voltage (V).

F. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs 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 VFC installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFC 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.

B. Install VFCs on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 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 Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 26 51 19

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.
3. Emergency lighting units.
4. Illuminated exit signs.

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.
2. Section 260933 "Central Dimming Controls" or Section 260936.19 "Standalone Multipreset Modular Dimming Controls" for architectural dimming systems and for fluorescent dimming controls with dimming ballasts specified in interior lighting Sections.

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: A complete lighting unit, exit sign, or emergency lighting unit. Fixtures include lamps or LED modules, and parts required to distribute the light, position and protect lamps or LED modules, and connect lamps or LED modules to the power supply.

H. Emergency Lighting Unit: A fixture with integral emergency battery power supply and the means for controlling and charging the battery. They are also known as an emergency light set. Emergency lighting units are available with and without integral heads.

I. UL: Underwriter's Laboratories, Inc.

1.4 SYSTEM DESCRIPTION

A. The interior lighting system shall include all lighting fixtures, lamps or LED modules, switches, mounting, wiring, control equipment, and accessories required for complete system, whether or not they are indicated or specified, as indicated in the Drawings and as specified.

B. The lighting fixture schedules in the Drawings indicate manufacturer, fixture design, appearance and performance desired.

C. Verify locations of light fixtures indicated in Drawings and coordinate with other reference data and materials as required prior to installation to ensure locations will not interfere with other work. Verify space above luminaires and confirm non-interference with other equipment, such as ducts, pipes, conduit and cabling, and openings. Alert Architect and Board Authorized Representative in writing to non-standard modifications required for compliance with the Contract Documents and for installation to coordinate with ceiling system before proceeding with the Work.

D. Verify dimensions. Where discrepancies are found within the Contract Documents, or additional information is required, immediately contact Architect for clarifications and additional information.

E. Coordinate installation of lighting system with other trades to prevent delays in the Work and to ensure the lighting fixtures and supports will not be damaged by subsequent construction operations.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
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 IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project.

    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. 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.

1.6 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. Lighting 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. Structural members to which equipment and or 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.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

D. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Certificates: For each type of luminaire.

F. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

G. Sample warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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. 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.

1.9 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: 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. Regulatory Requirements:

1. Comply with the City of Chicago Building Code.
2. Comply with EPA, State of Illinois, and City of Chicago regulations for proper recycling or disposal of existing lamps and ballasts removed from the Site.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Mockups: For interior lighting 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.

1.10 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. Coordinate installation of lighting fixtures indicated to extend in continuous, wall to wall installation. Provide field, or established, dimensions to luminaire manufacturer in sufficient time so not to cause delays in the Work.

C. Coordinate installation of lighting fixtures to allow for the recommended "burn-in" periods for the lamps installed.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.12 WARRANTY

A. Special Warranty: Submit a written warranty, beginning from date of Preliminary Acceptance / Substantial Completion, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship within the specified warranty period. Failures shall include, but not be limited to, deterioration of metal finishes. Warranty shall include all materials and components, as well as labor and equipment required to remove existing and install new materials and components.

1. Warranty Period for Electronic Ballasts: Five (5) years from date of Preliminary Acceptance / Substantial Completion.
2. Warranty Period for Electromagnetic Ballasts: Three (3) years from date of Preliminary Acceptance / Substantial Completion.
3. Warranty Period for Metal Finishes: Five (5) years from date of Preliminary Acceptance / Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Submit a written warranty, beginning from date of Preliminary Acceptance / Substantial Completion, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship within the specified warranty period. Warranty shall include all materials and components, as well as labor and equipment required to remove existing and install new materials and components.

1. Warranty Period for Emergency Lighting Unit Batteries: Ten (10) years from date of Preliminary Acceptance / Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency Fluorescent Ballast and Batteries: Ten (10) years from date of Preliminary Acceptance / Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

C. Special Warranty for Lamps: Submit a written warranty, beginning from date of Preliminary Acceptance / Substantial Completion, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship, f.o.b. the nearest shipping point to the Site, within the specified warranty period.

1. Warranty Period for Lamps: One (1) year from date of Preliminary Acceptance / Substantial Completion.

D. Special Warranty for LED Luminaires: Submit a written warranty, beginning from date of Preliminary Acceptance / Substantial Completion, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship within the specified warranty period. Failures shall include, but not be limited to, a failure of the LED modules or LED drivers.

1. Warranty Period for LED Luminaires: Five (5) years from date of Preliminary Acceptance / Substantial Completion.

1.13 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. Provide a manifest of all extra materials provided.

1. Lamps: 10 for every 100 (10 percent) of each type and rating installed, but not less than one of each type.
2. Plastic Diffusers and Lenses: 10 for every 100 (10 percent) of each type and rating installed, but not less than one of each type.
3. Battery and Charger Data: One for each emergency lighting unit.
4. Ballasts: 1 for every 100 (1 percent) of each type and rating installed, but not less than one of each type.
5. Globes and Guards: 1 for every 20 (5 percent) of each type and rating installed, but not less than one of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. Bulb shape complying with ANSI C79.1.

F. Lamp base complying with ANSI C81.61 or IEC 60061-1.

G. CRI of minimum 80. CCT of **3000 K**.

H. Rated lamp life of 50,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: **120 V ac**.

1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

L. Air-Handling Light Fixtures:

1. Air-Handling Plenum Return Fixtures:

    a. Provide units without heat extraction vents in the lamp cavity. Provide factory-installed airtight blanking plates in place of all heat extraction vents.
    b. Provide matte black baffles for end and/or side slots as required so that ceiling plenum is not visible from below.
    c. Provide Chicago Plenum rated fixtures for use in air-return plenums.
    d. Provide fixtures complying with the City of Chicago Environmental Air (CCEA) requirements.

2. Air-Handling Ducted Supply/Return Fixtures:

    a. Coordinate provision of air-handling fixtures with Division 23.
    b. Provide air-handling type lighting fixtures that perfectly accommodate the secure and airtight attachment of all air-handling components. Coordinate fit, performance, and installation requirements between the air terminal and lighting fixture manufacturers. Provide matching fixtures of the same type to present the same appearance in the ceiling whether active or inactive.

c. Provide each inactive fixture with the capability of activation by providing removable, air-tight blanking plates in place. Inactive fixtures shall become active when blanking plates are removed and appropriate air terminals are installed.
d. Do not provide fixtures that rely on the air-handling component to maintain proper position in the ceiling, whether fixture is active or inactive.
e. Provide Chicago plenum rated fixtures for use in air plenums.
f. Provide fixtures complying with the City of Chicago Environmental Air (CCEA) requirements.

M. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized or powder-coat finish.

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. 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.

C. Diffusers and Globes:

1. **prismatic 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.

D. Housings:

1. **Extruded-aluminum** housing and heat sink.
2. **Clear anodized** finish.

E. 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.

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 FIXTURE 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.

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 A 641/A 641 M, 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.

2.6 EXIT SIGNS

A. General: Comply with UL 924 and the Chicago Electrical Code for sign colors, visibility, luminance, and lettering size.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LED's, 70,000 hours minimum rated lamp life.
2. Self-Powered LED Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state, constant current type with integral sealed transfer relay.
    c. Operation: Relay automatically energizes LED module from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects LED modules from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. Pilot Light: Indicates when the battery charger is functioning, when tied to the normal source.
    f. Low Battery Disconnect: Provide a device and/or related circuitry that shall automatically disconnect the battery and protect it from deep/over discharge.
    g. Shall consume 5 watts of AC power, or less, per face under normal operating conditions.

2.7 EMERGENCY LIGHTING UNITS

A. General: Self-contained units complying with UL 924 and the Chicago Electrical Code.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. Pilot Light: Indicates when the battery charger is functioning, when tied to the normal source.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures. Provide wire guard at gymnasium, gym/cafeteria/assembly area, cafeteria, locker rooms, weight rooms, and in other locations as indicated.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

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 fixture installation. 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 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 vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

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 Luminaire Support:

1. **Attached to structural members in walls**.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with four-point pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. 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.
3. 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.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
2. 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.

J. 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 260943.23 "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.

END OF SECTION

SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.

B. Drivers

C. Lamps.

D. Poles and accessories.

E. Luminaire accessories.

1.02 REFERENCE STANDARDS

A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2014 (2015 Errata).

B. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signal; 2013 (Revised 2015).

C. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; 2011.

D. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing; 2010.

E. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

F. ASTM B429/B429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube; 2010e1.

G. City of Chicago Building Code - Municipal Code of Chicago for the Building Industry; 2017.

H. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

I. IEEE C2 - National Electrical Safety Code; 2017.

J. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.

K. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).

L. IES RP-8 - Recommended Practice for Roadway Lighting; 2014.

M. NAAMM (MFPM) - Metal Flagpole Manual; 1980.

N. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

O. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.

P. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

Q. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.

R. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

S. UL 1598 - Luminaires; Current Edition, Including All Revisions.

T. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
2. Notify Architect/Engineer of Record of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.04 SYSTEM DESCRIPTION

A. The exterior lighting system shall include all lighting fixtures, LED modules, switches, mounting, wiring, control equipment, and accessories, whether or not they are indicated or specified, required for a complete system, as indicated in the Drawings and as specified.

B. The lighting fixture schedules in the Drawings indicate manufacturer, fixture design, appearance and performance desired.

C. Verify locations of light fixtures indicated in Drawings and coordinate with other reference data and materials as required prior to installation to ensure locations will not interfere with underground utilities or openings. Alert Architect/Engineer of Record and Board's Representative in writing to non-standard modifications required for compliance with the Contract Documents prior to proceeding with the work.

D. Where discrepancies are found within the Contract Documents, or additional information is required, immediately contact Architect/Engineer of Record for clarifications and additional information.

E. Coordinate installation of lighting system with other trades to prevent delays in the work and to ensure the lighting fixtures and supports will not be damaged by subsequent construction operations.

1.05 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Live Load: Single load of 500 lbs, distributed as stated in AASHTO LTS-4.

C. Ice Load: Load of 3 lbs/sq. ft. applied as stated in AASHTO LTS-4.

D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.
   1. Wind speed for calculating wind load for poles exceeding 50 feet in height is 110 mph.
   2. Wind speed for calculating wind load for poles 50 feet or less in height is 110 mph.

1.06 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:
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include details that cannot be adequately represented to the satisfaction of the Architect/Engineer of Record in Product Data.
   3. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   4. Wiring Diagrams: For power, signal, and control wiring.
   5. Photometric data, certified by the manufacturer in accordance with the recommended practices of the IES.
   6. Quantity and type of LED modules.

D. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Provide separate submittal product data/shop drawings for each fixture type clearly indicating the fixture type designation used in the Drawings and all pertinent options and accessories. Do not group similar fixture types together on a single cut sheet. Submittals that do not indicate option selection where multiple selections exist will be returned without review. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaires and accessories.
   3. Details of installation and construction.
   4. Luminaire materials such as finish and color information.
   5. Photoelectric relays.
   6. LED Drivers: Include information as to input watts. Indicate mounting distance limitation and standard wire sizes for remote drivers.
   7. LED modules, per luminaire tag, including life, output, and energy-efficiency data.
   8. Materials, dimensions, accessories and finishes of poles.
   9. Photometric data based on laboratory tests of each luminaire type, complete with indicated LED modules, drivers, and accessories.

10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Pole and support structure anchor bolt information.
12. Manufactured pole foundations, if any.

E. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.

F. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a State of Illinois Registered Structural Engineer.

G. Field Quality Control Reports.
1. Include test report indicating measured illumination levels.

H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

I. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals. Include manufacturers' recommended maintenance practices for each fixture type including, but not limited to, the following:
1. Tools required.
2. Acceptable cleaners and recommended cleaning practices.
3. Replacement parts list.
4. Manufacturer service department contact information/Qualified Service Agencies.
5. Submittal data.
6. Operation data.
7. Intended operation narrative.

J. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes. Submit record drawings of the actual installation within thirty (30) days of date of Preliminary Acceptance.

K. Re-Commissioning Data: Submit manual containing all information required for re-commissioning of the installations.
1. Submit two (2) copies of manual within thirty (30) days of date of Preliminary Acceptance.
2. Submit re-commissioning manuals in heavy-duty, 3-ring binders. Submit manuals in accordance with Section 01 78 00 - Closeout Submittals.

1.07 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. Provide a manifest of all extra materials provided.
1. LED Modules: One (1) for every ten (10) of each type and rating installed. Furnish at least one (1) of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One (1) for every ten (10) of each type and rating installed. Furnish at least one (1) of each type.

3. Drivers: One (1) for every ten (10) of each type and rating installed. Furnish at least one (1) of each type.
4. Globes and Guards: One (1) for every twenty (20) of each type and rating installed. Furnish at least one (1) of each type.

1.08 QUALITY ASSURANCE

A. Comply with the City of Chicago Building Code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Chicago Electrical Code by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

F. Solid State Lighting/Luminaires:
1. Luminous flux, luminaire efficiency and chromaticity shall be tested, measured and reported in accordance with the most current versions of IES LM-79 and IES LM-80.
2. Chromaticity ranges for "white light" products, with various correlated color temperatures, shall be provided in accordance with ANSI/NEMA-C78.377.
3. Drivers and power supplies shall be provided in accordance with the requirements of ANSI/NEMA-C82.SSL1, and their maximum allowable harmonic emission limits shall be in accordance with ANSI/NEMA-C82.77.
4. Shall be provided with a U.S. Department of Energy (DOE) "Lighting Facts "label indicating their specific performance characteristics, tested and reported in accordance with the requirements of the most current version of IES LM-79.

G. Commissioning: When required for the Project, Contractor shall assign representative(s) with expertise and authority to act on its behalf. The representative(s) shall perform commissioning activities including, but not limited to, the following:
1. Review submittals relative to exterior lighting systems being commissioned.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12-inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Handle poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4-inch deep. Do not apply tools to section of pole to be installed below ground line.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation.

E. Deliver exterior lighting fixtures individually wrapped in factory-fabricated fiberboard type containers or equivalent.

F. Handle exterior lighting fixtures carefully to prevent breakage, denting and scoring the fixture finish. Do not install damaged lighting fixtures; replace and return damaged units to equipment manufacturer.

G. Store lighting fixtures in a clean, dry space. Store in original cartons and protect from dirt, physical damage, weather and construction traffic.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Special Warranty: Submit a written warranty, beginning from date of Preliminary Acceptance, and executed by the Contractor, manufacturer, and Installer agreeing to repair or replace products or components that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within the specified warranty period. Damage due to lightning, hail, vandalism, abuse, or unauthorized repairs or alterations shall be excluded from special warranty coverage. Warranty shall include all materials and components, as well as labor and equipment required to remove existing and install new materials and components.
   1. Warranty Period for LED Luminaires: Five (5) years from date of Preliminary Acceptance.
   2. Warranty Period for Metal Corrosion: Five (5) years from date of Preliminary Acceptance.
   3. Warranty Period for Color Retention: Five (5) years from date of Preliminary Acceptance.
   4. Warranty Period for LED Modules and Fuses: Two (2) years from date of Preliminary Acceptance.
      a. Replace LED modules and fuses that fail within twelve (12) months from date of Preliminary Acceptance.
      b. Furnish replacement LED modules and fuses that fail within the second twelve (12) months from date of Preliminary Acceptance.
   5. Warranty Period for Ballasts and Drivers: Five (5) years from date of Preliminary Acceptance.
   6. Warranty Period for Poles: Three (3) years from date of Preliminary Acceptance. Warranty shall include pole finish.
   7. Warranty Period for LED Drivers: Five (5) years from date of Preliminary Acceptance.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Provide for proper recycling or disposal of existing lamps and ballasts removed from the site in accordance with EPA and State of Illinois regulations.

PART 2 - PRODUCTS

2.01 LUMINAIRES

A. Manufacturers:

1. Products: Subject to compliance with requirements indicated and the design criteria specified in the Luminaire Schedule, provide one (1) of the products specified in the Fixture Schedule.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.
1. Fixtures that are aimed upward shall be listed and labeled for installation in wet locations in that position.

D. Provide products complying with Federal Energy Management Program (FEMP) requirements.

E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc. Components, including nuts, bolts, rivets, springs, and similar parts, to be made from corrosion resistant materials.

H. Provide luminaires listed and labeled as suitable for wet locations and outdoor service unless otherwise indicated.

I. Recessed Luminaires:
1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

J. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

K. LED Luminaires:
1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

L. Provide anodized aluminum for aluminum parts of exterior fixtures that are not specified as requiring a painted finish.

M. Lateral Light Distribution Patterns: Comply with IES RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

N. Metal Parts: Free of burrs and sharp corners and edges.

O. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

P. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

Q. 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. Designed to disconnect driver when door opens.

R. Exposed Hardware: Stainless steel.

S. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

T. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

U. 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.

V. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

W. 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.
1. Where luminaire products are not indicated to be field painted and are not indicated to match the finish process and color of pole or support materials, provide the following:
    a. 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) 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.

X. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. 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 and ballast characteristics:
    a. "USES ONLY" and include specific lamp type.
    b. CCT and CRI for all luminaires.

Y. Emergency Power: Provide emergency LED power pack with back box matching housing finish where indicated or, if not indicated, where required by Architect/Engineer of Record, or Board's Representative.

2.02 DRIVERS

A. Drivers - General Requirements:
1. LED drivers shall be factory provided by the respective luminaire manufacturers, and shall be suitable for their intended use, to operate the designated LED modules listed in the Luminaire Schedule, and as specified herein, to their full light output.
2. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
3. Provide complete connection to LED-type luminaries through both integrally installed and remote electronic drivers.
4. Shall be totally enclosed within a metallic enclosure, and shall be provided with integral leads color coded per ANSI C82.11, or with poke-in style wire retaining connectors.
5. Provide identical drivers within each luminaire type.
6. Provide UL listed and labeled drivers. Provide drivers with temperature ratings appropriate to the installation.
7. Surge Tolerance: Capable of withstanding characteristic surges, 10,000 aic minimum.
8. Fixtures intended to be dimmed shall have dimming driver compatible with the specified dimmer controls.
9. Remote Drivers:
   a. Remove drivers are specifically not indicated in Drawings. Install remove drivers in a readily accessible, dry, indoor, concealed location in accordance with the manufacturer's written instructions.
   b. Provide ventilated metal enclosures for remove drivers furnished as loose equipment. All wiring related to remove drivers and the related LED luminaries shall be installed in conduit.
   c. Verify and comply with the remote distance limitations specified by the luminaire/driver manufacturer.

2.03 POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.

B. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.

C. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

D. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

E. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
1. Materials: Shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
3. Anchor-Bolt Template: Plywood or steel.

F. Concrete Pole Foundations: Cast in place, not less than 24-inches in diameter, and extending above and below grade as indicated in Drawings. Install with anchor bolts to match pole-base flange. Provide raceways, grounding electrodes, and other electric work relating to the pole foundations. Refer to Section 03 30 00 - Cast-in-Place Concrete for concrete, reinforcement, and formwork.

G. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

H. Poles shall be provided with handhole, anchor bolt covers, and grounding lug.

2.04 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B429/B429M, Alloy 6063-T6 with access handhole in pole wall.
1. Shape: Round.
2. Mounting Provisions: Butt flange for bolted mounting on foundation.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Handhole: Provide handhole opening, nominal 3-inches by 5-inches, at approximately 18-inches above pole base, complete with weathertight cover and securing fastener.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, and then bolted together with stainless-steel bolts. Fabricated with span and rise as indicated in Drawings.
1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Same as pole.

F. Aluminum Finish: Comply with NAAMM (MFPM) "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. 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.

2.05 POLE ACCESSORIES

A. Duplex Receptacle: Where indicated, provide a 120V, 20A receptacle in a weatherproof assembly complying with Section 26 27 23 - Indoor Service Poles for ground-fault circuit-interrupter type.
   1. Recessed, 12 inches above finished grade.
   2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, color to match pole, that when mounted results in NEMA 250, Type 3R enclosure.
   3. With cord opening.
   4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Fusing: Provide in-line fuses at handhole in each pole for each light fixture. Shall be UL listed and labeled, single pole, 600VAC, breakaway style, in-line fuse holders, designed for field installation onto pole supported luminaires. Provide complete with fuses, sized to the specific load.

C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

2.06 EXTERIOR LIGHTING DEVICES

A. Lighting fixtures are scheduled in Drawings. Reference the Drawings for the specified and approved fixtures.

2.07 INTEGRAL PHOTOELECTRONIC CONTROLS

A. Integral, Luminaire Installed, Photocell:
   1. Where indicated, provide a photo-electronic device designed, built, and tested to provide automatic on/off control of individual luminaire, from dusk to dawn, based on ambient light level.
   2. Controls shall be UL 773A listed and fabricated to meet or exceed requirements of ANSI C136.10, with integral relay contacts rated not less than 1000VA to a ballasted load at not less than 300VAC.
   3. Provide controls with integral time delay feature to prevent false operation after momentary light flashes or light blockages.
   4. Controls shall be manufactured, or provided, by luminaire manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify that field measurements are as indicated.

D. Verify that lighting fixture back-boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with Chicago Electrical Code.

E. Verify that suitable support frames are installed where required.

F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

3.02 PREPARATION

A. Provide extension rings to bring lighting fixture back-boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

C. Demolition: Disconnect and remove luminaires, lamps, and accessories as indicated or, if not indicated, as directed by Architect/Engineer of Record. Disconnect and remove abandoned luminaires, lamps, and accessories. Remove from Site and dispose of legally.

D. Existing Installations: Extend existing installation using materials and methods specified.

E. Existing Fixtures to Remain or be Reinstalled: Clean and repair existing luminaires to remain and those indicated to be removed and reinstalled.

3.03 INSTALLATION

A. Coordinate locations of lighting fixture back-boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install products in accordance with manufacturer's instructions.

D. Install luminaires in accordance with NECA/IESNA 501.

E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

F. Recessed Luminaires:
1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

G. Suspended Luminaires:
1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.
5. Unless otherwise indicated, support pendants from swivel hangers.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
   1. Where fixtures protrude from the wall surface, provide additional structural support within the wall framing to accommodate the extra moment force created by the fixture

I. Pole-Mounted Luminaires:
   1. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
   2. Maintain the following minimum clearances:
      a. Comply with IEEE C2.
      b. Comply with utility company requirements.
         1) Fire Hydrants and Storm Drainage Piping: 60 inches.
         2) Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
      c. Trees:
         1) Less than 4-inch caliper: 15 feet.
         2) Greater than 4-inch caliper: Locate outside dripline.
   3. Foundation-Mounted Poles:
      a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 03 30 00 - Cast-in-Place Concrete.
         1) Install anchor bolts plumb per template furnished by pole manufacturer.
         2) Position conduits to enter pole shaft.
      b. Install foundations plumb.
         1) Exposed concrete surfaces of bases for all light poles and light fixtures shall be free of voids.
      c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
         1) Use anchor bolts and nuts selected for the application and approved by manufacturer.
         2) Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
         3) Install base covers, unless otherwise indicated.
         4) Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
      d. Tighten anchor bolt nuts to manufacturer's recommended torque.
      e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
      f. Install anchor base covers or anchor bolt covers as indicated.
      g. Remove all rough edges from exposed surfaces. Leave exposed surfaces smooth.
      h. Remove all exposed forming materials.
   4. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.
   5. Embedded Poles: Install poles plumb as indicated.
   6. Grounding:
      a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
      b. Provide supplementary ground rod electrode as specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems at each pole bonded to grounding system as indicated.
   7. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.

8. Install non-breakaway in-line fuse holders and fuses complying with Section 26 28 13 - Fuses in pole handhole or transformer base for each ungrounded conductor.
9. Install weather resistant GFI duplex receptacle with weatherproof cover as specified in Section 26 27 26 - Wiring Devices - Lutron in designated poles.

J. Install accessories furnished with each luminaire.

K. Ground metal poles and support structures according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
1. Install a minimum of a 3/4-inch diameter by 8-foot copper grounding electrode for each pole, unless otherwise indicated, and installed as indicated in Drawings.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

L. Raise and set poles using web fabric slings (not chain or cable).

M. Installation of Individual Ground-Mounted Luminaires: Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00.

3.04 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 26 05 33.13 - Conduit for Electrical Systems. In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a fifty (50) percent overlap.

3.05 RACEWAYS AND BOXES

A. Plastic conduit shall be used where indicated in Drawings, in unpaved areas and lawn areas. The conduit shall be Schedule 40, UL Listed, polyvinyl chloride conduit, and not less than 1-1/2 inches in diameter.

B. Galvanized rigid conduit shall be used under buildings, within five feet of entrances to buildings, in pole foundations, under paved areas and walkways, and within 18-inches, horizontally, of exterior junction boxes.

C. Provide pull line in empty conduit and duct.

D. Comply with the additional requirements of Section 26 05 33.13 - Conduit for Electrical Systems, 26 05 33.16 - Boxes for Electrical Systems, and 26 05 33.23 - Surface Raceways for Electrical Systems.

3.06 IDENTIFICATION

A. Provide vinyl tagging with panel source and circuit number on wiring at handhole in each pole and at each exterior box.

B. Identify each exterior box with 1-1/2 inch high black letters and numbers on yellow weatherproof, pressure-sensitive adhesive vinyl on the covers. Labels shall be Brady #1530.

C. Identify each pole with 3-1/2 inch high black letters and numbers on yellow weatherproof, pressure sensitive adhesive vinyl placed 78-inches above grade facing the parking areas, or facing the road if the pole is at the road. Labels shall be Brady #1550.

D. Comply with the additional requirements of Section 26 05 53 - Identification for Electrical Systems.

3.07 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect/Engineer of Record.

E. Measure illumination levels at night with calibrated meters to verify conformance with performance requirements. Record test results in written report to be included with submittals.

3.08 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect/Engineer of Record. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources. Secure locking fittings in place.

B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect/Engineer of Record.

3.09 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.10 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Inspect each installed fixture for damage. Replace damaged fixtures and components.

D. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.

E. Replace fixtures that show evidence of corrosion during project warranty period.

F. 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 requirements.

G. Training: Perform on-site training of Board's personnel on operation, adjustment, and maintenance of exterior lighting. Training shall last a minimum of 4 hours and at the end of the session, the Board's maintenance personnel shall be thoroughly instructed in the proper operation of the system.

3.11 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

3.12 COMMISSIONING AND DEMONSTRATION

A. After system checkout and adjustment, the contractor shall operate the system for the review of Architect/Engineer of Record and Board's Representative, and shall make all adjustments and modifications as required by Architect/Engineer of Record and Board's Representative.

END OF SECTION

SECTION 27 00 00

COMMUNICATION GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section used in conjunction with each separate specification section outline the general communications design requirements, administration topics, and installation requirements for Information Technology System (ITS).

B. Related Requirements

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

2. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them, including but not limited to the following:

3. This specification covers all general requirements for work under this contract and the following specification sections:

a. Section 27 05 26 - Bonding and Grounding
b. Section 27 05 28 - Pathways
c. Section 27 05 33 - Conduits and Boxes
d. Section 27 05 53 - Identification
e. Section 27 08 00 - Commissioning
f. Section 27 11 19 - Termination Blocks and Patch Panels
g. Section 27 13 33 - Coaxial Backbone Cabling
h. Section 27 13 34 - Coaxial Splicing and Termination
i. Section 27 15 13 - Copper Horizontal Cabling
j. Section 27 15 43 - Faceplates and Connectors

1.2 REFERENCES:

A. Abbreviations:

1. A/E: Architect / Engineer (designer)
2. ACT: Acoustical Ceiling Tile
3. BET: Building Entrance Terminal
4. CBC: Coupled Bonding Conductor
5. CFOI: Contractor Furnished Owner Installed
6. E.E. Electrical Engineer
7. EMI: Electromagnetic Interference
8. GE: Ground Equalizer
9. IDC: Insulation Displacement Contact
10. IDF: Intermediate Distribution Facility
11. I/O: Information Outlet or Work Area Information Outlet

12. LAN: Local Area Network
13. LOMMF: Laser Optimized Multimode Fiber
14. MC: Main Cross-Connect
15. MDF: Main Distribution Facility
16. NIC: Not In Contract
17. OTDR: Optical Time Domain Reflectometer
18. RCDD: Registered Communications Distribution Designer
19. TBB: Telecommunications Bonding Backbone
20. TBC: Telecommunications Bonding Conductor
21. TGB: Telecommunications Ground Bus Bar
22. TMBC: Telecommunications Main Bonding Conductor
23. TMGB: Telecommunications Main Grounding Bus Bar

1.3 REFERENCE STANDARDS & CODES:

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. The publications listed in this section form a part of this specification. The publications are referred to in the text of applicable specifications by basic designation only.

D. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest edition of each as adopted by the projects local AHJ.

E. It shall be the responsibility of the installing contractor to verify the applicable code version for all work performed with the authority having jurisdiction (AHJ).

F. Conflicts:

1. Drawings and specifications are to be used in conjunction with one another and to supplement one another. In general, the specifications determine the nature and quality of the materials and tests, and give characteristics of performance that should be adhered to in the installation of the communications system components, the drawings establish the quantities and details of installation.
2. If there is an apparent conflict between the drawings and specifications, or between specification sections, the items with the greater quantity or quality shall be estimated and installed.
3. Clarification with the Owner and/or Owner's Representative about these items shall be made prior to ordering and installation of components.

G. All materials, installation and workmanship shall comply with the most recently approved applicable reference standards and codes addressed within each specification document.

1. The latest edition of all listed standards as current as of the date that the work is advertised for bids
2. The latest edition of the codes as approved and adopted by the agency/authority having jurisdiction (AHJ) as of the date that the work is advertised for bids, shall apply to the work under the Contract Documents.
3. Codes and Regulations: (Note: Reference Division One for specific code versions governing the work in addition to the information noted below.)
    a. National Electric Code (NEC)
    b. National Electric Safety Code (NESC)
    c. National Fire Protection Association (NFPA)
    d. Life Safety Code (NFPA 101)
    e. Local Municipal Codes
4. ANSI/IEEE 802.12 100Base-TX Ethernet
5. ANSI/IEEE 802.3ab 1000Base-T Ethernet Specification
6. ANSI/IEEE 802.3ae 10Gb/s Ethernet Specifications
7. ANSI/IEEE 802.11 Wireless Ethernet Specifications, including 802.11a, 802.11b, 802.11g, 802.11n, 802.11ac and 802.11ax
8. EIA-310 Cabinets, Racks, Panels and Associated Equipment Standard
9. ANSI/TIA/EIA-455-57 FOTP-57, Preparation and Examination of Optical Fiber End Face for Testing Purposes
10. ANSI/TIA-455-78 FOTP-78, Measurement Methods and Test Procedures – Attenuation
11. ANSI/TIA-455-95 FOTP-95, Absolute Optical Power Testing for Optical Fiber and Cables
12. ANSI/TIA-455-133 FOTP-133, Measurement Methods and Test Procedures – Length Measurement
13. TIA-492AAAD Detail specification for 850-nm laser-optimized, 50-um core diameter/125-um cladding diameter class Ia graded-index multimode optical fibers
14. TIA-492CAAB Detail Specification for Class lVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak
15. ANSI/TIA-526-7 OFSTP-7, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
16. ANSI/TIA-526-14 OFSTP-14, Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant
17. ANSI/TIA/EIA-568 Series of Standards for Commercial Building Telecommunications
18. ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
19. TIA-598 Optical Fiber Color Coding
20. ANSI/TIA-606 Administration Standard for Telecommunications Infrastructure
21. TIA-607 Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises

22. ANSI/NECA/BICSI 607 Standard for Telecommunications Bonding and Grounding
23. TIA-758 Customer-owned Outside Plant Telecommunications Infrastructure Standard
24. ANSI/TIA-942: Telecommunications Infrastructure for Data Centers
25. ANSI/TIA-1179-2010 “Healthcare Facility Telecommunications Infrastructure Standard”.
26. ANSI/UL1479, “Fire Tests of Through Penetration Firestops”.
27. ASTM E 814, “Fire Tests of Through Penetration Firestops”.
28. BICSI - Telecommunications Distribution Methods Manual
29. BICSI - Information Technology Systems Installation Manual
30. BICSI - Outside Plant Design Reference Manual
31. BICSI - Electronic Safety and Security Design Reference Manual
32. Underwriters Laboratories (UL) Cable Certification and Follow-Up Program.
33. National Electrical Manufacturers Association (NEMA)
34. American Society for Testing Materials (ASTM)
35. Institute of Electrical and Electronic Engineers (IEEE)
36. UL Testing Bulletin
37. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be indicated in the proposal the components that may be of foreign manufacture, if any, and the country of origin.

1.4 SCOPE OF WORK:

A. Work of this section covers a complete installation of both permanent and channel links for a Structured Information Technology Infrastructure utilizing copper and fiber transmission media that includes, but is not limited to the following. The Contractor shall:

1. Comply with all Master Specifications documents and requirements for a complete and functioning project installation.
2. It shall be the responsibility of the Division 27 contractor to coordinate with Division 26 and other trades to ensure pathways and all infrastructure are installed to comply with all specifications and contract documents.
    a. Verify conduit routing does not cause cabling to exceed specified electrical length, pulling tension, bend radius, or bend quantity.
    b. Verify Bonding and grounding from MER and TR rooms to Grounding Electrode System provided by Division 26 contractor meets Division 27 specifications.
3. Provide a structured cabling system as described hereafter that includes, but is not limited to, supplying, installing, labeling and testing of: fiber and copper riser and backbone cable; fiber and copper horizontal cabling, cable connectors, communications outlets and terminations, and equipment racks/cabinets for

networking hardware, patch panels, and patch cords as required to provide a complete and functioning system.

4. Furnish all labor, materials, tools, equipment and services for the installation described herein. Provide add/deduct unit pricing for all components as part of the bid response. Assume an average cable length of 180 linear feet for comparative purposes. All requirements and specifications shall be enforced. Cable pathways and runs to individual outlets are not shown in their entirety, but shall be provided as if shown in their entirety.
5. Follow industry standard installation procedures for communications cable to assure that the mechanical and electrical transmission characteristics of the installed cable plant and equipment are maintained.
6. Verify or provide and install UL-listed firestopping systems in all communication pass-throughs, conduits and cable trays, used in ceiling, wall and floor penetrations in coordination with General Contractor.
7. Provide Submittals prior to commencement of work as outlined later in this specification.
8. Conduct a final document handover meeting with client, consultant, and PM to review, discuss and educate the Owner on the test results and As-Built Drawings.
9. Provide a Manufacturer's Extended Product Warranty and System Assurance Warranty for this structured cabling system.

B. Fire rated cable pathway devices shall be used in fire-rated construction for ALL low-voltage, video, data and voice cabling, optical fiber raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:

1. Meet the hourly fire-rating of fire rated wall and or floor penetrated.
2. Be tested for the surrounding construction and cable types involved.
3. Have UL Systems permitting cable loads from; "*Zero to 100% Visual Fill*." This requirement eliminates need for fill-ratio calculations to be made by cable technicians to ensure cable load is within maximum allowed by UL System.
4. Not have inner fabric liner that tightens around and compresses cables tightly together encouraging potential cable damage or interference.
5. Be "Zero-Maintenance", zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
    a. Opening or closing of doors.
    b. Spinning rings to open or close fabric liner.
    c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
    d. Evaluation Services Report (ESR) from an accredited Nationally Recognized Third-party Laboratory certifying compliance with this definition of "Zero-Maintenance" and all relevant codes and standards.
6. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.

7. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
8. Cable Pathway Devices passing vertically through floors shall have equal F & T Rating.
9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.

C. Non rated cable pathway devices shall be used in non-fire-rated construction for ALL low-voltage, video, data and voice cabling, optical fiber raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:

1. Limit the movement of smoke and sound of wall and or floor penetrated.
2. Restore the STC Rating of the penetrated assembly.
3. Provide L Ratings of <1 CFM when empty and <2.5 CFM at all other loading up to 100 percent.
4. Accommodate cable loads from; "*Zero to 100% Visual Fill*."
5. Not have inner fabric liner that tightens around and compresses cables tightly together encouraging potential cable damage or interference.
6. Be "Zero-Maintenance", zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
    a. Opening or closing of doors.
    b. Spinning rings to open or close fabric liner.
    c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
7. Furnish letter from manufacturer certifying compliance with this definition of "Zero-Maintenance". Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
8. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.

D. As an alternate to using a fire-rated or non-rated cable pathway device for single low voltage cables (up to 0.27 in. (7 mm) O.D) penetrating one or two-hour, gypsum board/stud wall assemblies or non-rated assemblies, either as a through-penetration or as a membrane-penetration, a fire-rated cable grommet may be substituted. The product shall consist of a molded, two-piece, plenum-rated grommet having a foam fire and smoke sealing membrane that conforms to the outside diameter of the individual cable. The grommet product shall be capable of locking into place to secure the cable penetration within the wall assembly. The grommet shall be UL Classified and tested to the requirements of ASTM E814 (UL1479) and CAN/ULC S115.

E. Where non-mechanical pathways must be utilized, such as sealing (caulking) around single or grouped conduits, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction. Provide letter from manufacturer certifying compliance with this section.

F. Cable pathway shall replace conduit sleeves in walls and floors, and;

a. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
b. When multiple units are ganged in floors, devices shall be anchored by means of a tested grid.
c. When installed individually in walls, devices shall pass through core drilled opening utilizing tested wall plates or integrated flanges.
d. When multiple units are ganged in walls, devices shall be anchored by means of a tested grid.

G. Cable tray shall terminate at each barrier and resume on the other side such that cables pass independently through devices. Cable tray shall be properly supported on each side of the barrier.

1.5 PRODUCTS AND WORK BY OTHERS (NIC) INCLUDES:

A. The Owner may separately purchase and/or provide certain equipment and miscellaneous items that will be installed during the course of the installation process. Such items may not be indicated in the project documents. Contractor shall coordinate with the Owner to ensure the ITS is built factoring:

1. Provision and installation of phone systems, computer hardware, and related networking software and equipment.
2. Provision and installation of UPS in communications rooms.
3. Communications grounding busbars and bonding conductors connecting to the main building electrode system.
4. Dedicated power panels, ground busbars, circuits and utility outlets.
5. Installation and finishing of plywood backboards.
6. Building mechanical ductwork, cooling/heating system, and environmental control sensors.
7. Communication pathway devices such as, but not limited to, cable tray and flex-tray in corridors, office spaces and open areas, conduits, conduit sleeves, and penetrations in walls and floors.

1.6 MEASUREMENT PROCEDURES:

A. The Contractor shall

1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements and scale on shop drawings.
2. Coordinate fabrication schedule with construction progress to avoid delaying the project.

3. Where field measurements cannot be made without delaying the project, establish dimensions and coordinate with the General Contractor, and when approved, proceed with fabricating units without field measurements.
4. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.
5. Immediately notify the Project Team of any discrepancies before and during construction.

1.7 ALTERNATES:

A. If an alternate material is proposed that is equal to or exceeds specified requirements, Contractor shall provide manufacturers' specifications in writing for Owner approval prior to purchase and installation.

B. Substitutions of material by the Contractor shall be in writing complete with written manufacturers' specifications. The material substituted shall not void, alter or change manufacturers' structured cabling system warranty.

C. Contractor shall:

1. Provide a complete cabling ITS infrastructure according to the project written specifications and drawings.
2. Respond to these changes with a complete material list, including pricing, labor, and taxes in writing presented to the Owner's Representative for approval.
3. Not proceed with additional scope of work without a signed approval by the Owner.

D. Any additional work performed by the Contractor without signed approval of these changes shall be at the contractors own risk. Contractor will submit a copy of signed change order upon billing.

1.8 SUBSTITUTION PROCEDURES

A. Substitution may be considered when a product becomes unavailable through no fault of the Contractor.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Include in each request for substitution:

1. Product identification, manufacturer's name and address.
2. Product Data: Description, performance and test data, reference standards, finishes and colors.
3. Samples: Finishes
4. Complete and accurate drawings indicating construction revisions required (if any) to accommodate substitutions.
5. Data relating to changes required in construction schedule.
6. Cost comparison between specified and proposed substitution.
7. Product specification cut sheets.

C. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require revision to the Contract Documents.

D. The Owner will be the final judge of acceptability, with review by Owner's Representative and the distribution of the acceptance by the Architect. No substitute shall be ordered, installed or utilized without the Architect's prior written verification of acceptance from the Owner.

1.9 SYSTEM DESCRIPTION:

A. The objective of this project is to provide a complete ITS infrastructure installation including, but not limited to: fiber backbone, riser system, horizontal data and voice cabling with associated terminations, mounting equipment, cable pathway and management systems, testing and other items/materials, as specified in drawings, these specifications, and contract documents.

1.10 SUBMITTALS:

A. The Contractor:

1. Shall submit a minimum of six (6) weeks prior to the commencement of any work all shop drawings, product data, or samples for approval by the Owner's Representative. Such work shall be in accordance with the requirements of all specification sections related to the work.

a. Shop drawings as required by the owner or as a minimum to include an electronic set of plan view and elevations of all work to be installed. The Contractor shall make any corrections required by the owner or the owner's representative or consultant team, file corrected copies and furnish such other copies as may be needed. The consultant's approval of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from drawings or specifications, unless the Contractor has in writing called the Architect's attention to such deviations at the time of submission, nor shall it relieve the Contractor from responsibility for errors of any sort in shop drawings or schedules.

2. Shall not perform any portion of the work that would disqualify any part or all of the ITS installation from the Manufacturer's warranty qualification.

B. The Contractor shall provide a copy of the Certified Test Data Sheet, available from the delivering distribution warehouse for either a full run or cut piece from the Master Reel of the fiber cable to be installed

1. The Certified Test Data Sheet shall include the Master Reel number, cable description, a passing test result with details, test equipment description, date certified, and a certificate of compliance stamp, and shall be included in the O&M Manual as a component of the final deliverables submittal package.

2. Contractor shall also include a copy of their acceptance test performed prior to installing the delivered optical fiber.

C. The Contractor shall provide the appropriate documentation from the certifying manufacturer showing the project is registered and qualified for the System Assurance Warranty. All subsequent work shall be in accordance with approved submittals.

D. The Contractor's BICSI Registered Communications Distribution Designer (RCDD) supervisor shall review, approve and stamp all documents prior to submitting. The Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements specified herein upon completion of all work.

E. Product Certificates shall be signed by manufacturers of cables, connectors, and terminal equipment certifying that products furnished comply with requirements.

F. Contractor shall submit the required Field Test Reports in the format and media specified, upon completion of testing the installed system.

G. Contractor shall deliver manufacturer's signed long-term Warranty of installed cabling system to include all components that comprise the complete cabling system. Delivery to be affected within two weeks of the time of final punch list review. Failure of any component to pass system component tests shall be promptly corrected, repaired or replaced to meet standards compliance. Contractor shall coordinate with manufacturer for warranty paperwork and procedures prior to the start of the project.

H. Cable Commissioning Plan:

1. The Contractor shall:

   a. Provide a complete and detailed commissioning plan for approval of the cabling system specified herein, including a complete list of test equipment for copper and fiber optic components and accessories prior to beginning cable testing. The following minimal items shall be submitted for review:
   b. Comply with all testing procedures and methods as listed in Specification 27 08 00 Communication Commissioning.
   c. Provide product data for test equipment
   d. Provide certifications and qualifications of all persons conducting the testing.

2. Calibration certificates indicating that equipment calibration meets National Institute of Standards and Technology (NIST) standards and has been calibrated at least once within the previous year of the testing date.

   a. Include validation, and testing. Owner will require that the communications cabling system installed by the Contractor be fully certified to meet all necessary requirements to be compliant with referenced IEEE and TIA standards, specifications, and vendor's warranty.
   b. Will determine the source/cause of test failure readings and correct malfunctioning component and/or workmanship within each channel or permanent link and retest to demonstrate compliance until corrected failure produces a passing result.

I. Cable Testing Reports: The Contractor shall submit cable test reports as follows:

1. Submit certified test reports of Contractor-performed tests.

   a. The tests shall clearly demonstrate that the media and its components fully comply with the requirements specified herein.
   b. One (1) set of electronic version of test reports shall be submitted together and clearly identified with cable identification.

c. Include software required to read test reports.

2. Cable inventory data shall be submitted for all fiber, copper, and coaxial cabling and termination equipment. Submit data electronically on CD-ROM, listing products furnished, including:

a. Manufacturer's name.
b. Manufacturer's part numbers.
c. Cable numbers.
d. Location and riser assignments.
e. Product Data:

3. Equipment and materials shall be standard products of a manufacturer regularly engaged in the manufacture of communications cabling products and shall be the manufacturer's latest standard design in satisfactory use for at least one year prior to bid opening.

J. Shop Drawings:

1. The Contractor shall:

a. Submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be marked with an arrow, highlighted, or underlined to indicate exact selection.
b. Identify applicable specification section reference for each product performance for each component specified for approval prior to purchase and installation.
c. Submit for approval diagrams showing room layouts, rack layouts (including elevations), riser layouts, etc.
d. Submit sample floor plan demonstrating outlet administration, clearly identifying each outlet with correct nomenclature, and legibly located on drawing.

K. Qualifications:

1. The Contractor shall provide the appropriate documentation to comply with the requirements described in SECTION 1.12- QUALITY ASSURANCE, included with, and at the time of bid submittal.

L. Closeout Submittals (As-built Drawings):

1. As-Built drawings are to be supplied to the Architect to prepare the Record Drawings.

2. As-Built drawings shall be in AutoCAD format, same version as used by Architect and consultant. Dimensions and scale of the drawing sheets submitted shall match the size of the drawing used for the contract documents, and shall include the cable numbers labeled in accordance with this document.

3. Utilize industry recognized drafting procedures that match Architect and consultant guidelines, methodology, and symbols.

4. The As-Built drawings shall incorporate all changes made to the building identified in, but not limited to, addendum, change notices, site instructions or deviations resulting from site conditions.

5. Contractor shall:

a. Clearly identify any resubmitted drawing sheets, documents or cut sheets either by using a color to highlight or cloud around resubmitted information.
b. Maintain drawing numbering, and graphic symbol consistency as per drawings issued by Architect

6. Provide dimensioned plan and elevation views of networking components, showing:

a. All communications data/voice outlet locations complete with outlet/cable labeling.
b. Cable routing paths of communications cables to identified infrastructure pathways.
c. All rack and cabinet locations and labeling thereof.
d. Standard or typical installation details of installations unique to Owner's requirements.

1.11 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Contractor shall supply all city, county, and state communication cabling permits required by appropriate governing agency.
2. Contractor shall be state-licensed and/or bonded as required for communications/low voltage cabling systems.

B. Certifications:

1. Contractor shall submit an up-to-date and valid certification verifying qualifications of the Contractor and installers to perform the work specified herein at time of bid submission.
2. Contractor shall have a complete working knowledge of low voltage cabling applications such as, but not limited to data, voice and video network systems.
3. Contracting firm shall have installed similar-sized systems in at least ten (10) other projects in the last five years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document. Certification shall include, but not be limited to, items such as name and location of project contacts and numbers, total square footage, total number of cables/drops, types of media, etc.
4. Contractor shall provide certificates for the appropriate insurance coverage as defined in contract documents.
5. All installer personnel that will be assigned to this project shall be listed in the qualification questionnaire document. 25% shall have a minimum of 3 years' experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid. Any personnel substitutions shall be noted in writing to Owner prior to commencement of work.
6. Contractor shall provide a registered BICSI Technician who shall act as the on-site Foreman throughout the duration of the project.
7. Contractor shall submit evidence of compliance with these requirements prior to beginning work on the project.

8. Cabling installers shall be trained and certified by the connectivity/cable manufacturer for communication cabling installations and maintenance of said materials. Refer also to General Conditions.

C. Products/Systems: Provide firestopping systems that comply with the following requirements:

1. Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.

2. Firestopping products bear the classification marking of qualified testing and inspection agency.

3. Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

1.12 ADMINISTRATIVE REQUIREMENTS AND COORDINATION:

A. The Contractor shall:

1. Provide a specified contact person (name and contact number) for coordination to attend project meetings with the communication consultant, the Owner and others.

2. Install and coordinate the communications cabling work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the A/E. Any repairs or changes made necessary in the contract work, caused by the contractors' neglect, shall be made by the contractor at their own expense

3. Coordinate work of this section with Owner's telephone system specifications, workstations, equipment suppliers, and installers.

4. Coordinate installation work with other crafts (examples include ceiling grid contractors, HVAC and sheet metal contractors, etc.) to resolve procedures and installation placement for cable trays and cable bundle pathways. The goal of this coordination will be to establish priority pathways for critical structured cabling infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components. Damage by Contractor to the craftwork of others will be remedied at the Contractor's expense in a timely manner.

5. Exchange information and agree on details of equipment arrangements and installation interfaces. Record agreements reached in meetings and distribute record to other participants, Owner and communication consultant.

6. Adjust arrangement and locations of distribution frames, patch panels, and cross-connect blocks in equipment rooms and racks to accommodate and optimize arrangement and space requirements of any service provider equipment, telephone system, and LAN equipment. Tasks shall be coordinated with Owner or his representative, and other trades' installation representatives.

7. Where installed, confirm exact locations and method of mounting outlets in modular furniture. Follow furniture manufacturers' written instructions for installing cable and devices in modular partitions. Obtain modular furniture and

power pole locations from the General Contractor. Cabling locations noted in plans along walls or in floors for modular furniture are approximate and will have to be determined by Contractor at time of installation. Field condition adjustments for installation shall be made and coordination efforts with the electrical contractor for pathway must take place early on in the project to comply with maximum 40% conduit fill ratio requirements.

8. When requested by Owner or Owner's representative, furnish extra materials that match specified products and that are factory packaged with protective covering for storage and identified with labels describing contents.

B. Related Documents:

1. Drawings and General provisions of the contract, including Uniform General Conditions, Supplementary General Conditions, architectural plans and specifications, requirements of Division 01, electrical, mechanical, plumbing, audio visual, security and communications specifications and plans apply to the communications section, and shall be considered a part of this section. The Contractor shall read all sections in their entirety and apply them as appropriate for work in this section.

2. Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Manager.

3. The Contractor will respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to extent necessary, consistent with the legal responsibilities of the Owner's policies.

4. When required the contractor shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this project.

5. Use of Subcontractors: Successful bidder shall inform the Owner's contact and General Contractor in writing about the intention to use Subcontractors and the scope of work for which they are being hired. The Owner or Owner's designated contact must approve the use of Subcontractors in writing prior to the Subcontractor's hiring and start of any work.

6. The Contractor's designated project manager will be recognized as the single point of contact. The Project manager shall oversee all work performed to ensure compliance with specifications as outlined in bid documents (which includes all specifications and drawings) to ensure a quality installation.

1.13 CONTRACT ADMINISTRATION:

A. Change orders shall be submitted to the Owner/Project Manager complete with price breakdown and description for approval before any work is done.

B. Owner's Representative will provide job field reports upon inspection of Contractor's installation, materials, supporting hardware, coordination with other trades and progress to schedule to the client.

C. Job Field Report outline:

1. General installation progress in relation to scheduled work made by the Contractor up to that date.
2. All deficiencies noted in the cable installation to be corrected by the Contractor.

D. Pre-Installation Meetings - Contractor shall:

1. Attend and/or arrange a scheduled pre-installation conference prior to beginning any work of this section.
    a. Agenda: This venue is to ask and clarify questions in writing related to work to be performed, scheduling, coordination, etc. with consultant and/or project manager/Owner representative.
    b. Attendance: Communications project manager/supervisor shall attend meetings arranged by General Contractor, Owner's representatives, and other parties affected by work of this document.
    c. All individuals who will supervise installers of communication cables and equipment on-site, including project managers and lead installers, shall be required to attend the pre-installation conference. Individuals who do not attend the conference will not be permitted to supervise the installation of communications cables on the project.

E. Post-Installation Meetings:

1. At the time of substantial completion, or shortly thereafter, the Contractor shall call and arrange for a post-installation meeting to present and review all submittal documents to include, but not limited to as-built drawings, test reports, warranty documentation, etc. Attendees shall be Owner staff, Owner's Representative, General Contractor, and others that the General Contractor deems appropriate.
2. At this meeting the Contractor shall present and explain all documentation, and asking for feedback on its completeness. Any discrepancies or deviations noted by and agreed to by participants shall be remedied by Contractor and resubmitted within one week of meeting.

1.14 DELIVERY, STORAGE, AND HANDLING:

A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Contractor.

B. Contractor Shall:

1. Be responsible for prompt material deliveries to meet contracted completion date.
2. Coordinate deliveries and submittals with the General Contractor to ensure a timely installation.
3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
5. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.

6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.

7. Contractor shall be responsible for all handling and control of equipment. Contractor is liable for any material loss due to delivery and storage problems.

C. Owner/General Contractor shall supply a list of security requirements for Contractor to follow.

1.15 PROJECT/SITE CONDITIONS

A. For all environmental recommendations, refer to master Architectural section.

B. For all security recommendations, refer to related Division 01.

C. After completing system installation, including outlet fittings and devices, inspect exposed finish. Contractor will remove burrs, dirt, and construction debris. If applicable, the Contractor will repair damaged finishes, including chips, scratches, and abrasions.

D. Contractor shall provide daily a clean work environment, free from dust, trash/rubbish accumulated during and after cabling installation.

E. Communication spaces shall be maintained in a dust/debris free manner at all times.

F. Contractor shall keep all liquids (drinks, sodas, etc.) off finished floors, carpets, and tiles. If any liquid or other detriment (cuts, soils, stains, etc.) damages the above finishes, Contractor shall provide professional services to clean or repair scratched/soiled finishes, at Contractor's expense.

G. Contractor shall coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

H. Contractor shall coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

I. Contractor shall schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings

1.16 WARRANTY

A. Contractor shall provide a minimum one (1) year warranty on installation and workmanship PLUS an Extended Product Warranty and System Assurance Warranty for this cabling system and shall commit to make available local support for the product and system during the Warranty period.

1. The Extended Product Warranty shall apply to all passive structured cabling system components and shall cover the replacement or repair of defective products and labor for the replacement or repair of such defective products for a minimum of one (1) year.

2. The System Assurance Warranty provides a complete system and product warranty that will be extended to the end-user, ensuring the structured cabling system will

be free of defects in materials and workmanship, will meet or exceed applicable performance requirements defined in the most current version of the Commercial Building Telecommunications Cabling Standards, and support all current network applications for a minimum of twenty (20) years.

B. System Certification: Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate, from the manufacturer, registering the installation.

1.17 MAINTENANCE

A. Support Availability: The Contractor shall commit to make available local support for the product and system maintenance during the Warranty or Extended Warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Comply with specifications for each specific Division 27 section for acceptable products.

B. All materials shall be UL and/or ETL listed and labeled in accordance with NFPA 70 for all products where labeling service normally applies.

C. Materials and equipment requiring UL 94, 149 or 1863 listing shall be so labeled. Modification of products that nullifies UL labels is not permitted.

D. The installed systems shall not generate nor be susceptible to any harmful electromagnetic emission, radiation, or induction that degrades, or obstructs any equipment.

E. All material and equipment as provided should be the standard Commercial-Off-The-Shelf (COTS) products of a manufacturer engaged in the manufacturing of such products. All shall be typical commercial designs that comply with the requirements specified. All material and equipment shall be readily available through manufacturers and/or distributors.

F. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.

G. Expansion Capability: Unless otherwise indicated, provide spare positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in campus distribution and active workstations.

H. Backward Compatibility: The provided solution shall be backward compatible with lower category ratings such that if higher category components are used with lower category components, the basic link and channel measures shall meet or exceed the lower channel’s specified parameters.

I. Component Compliance: The provided solution’s components shall each meet the minimum transmission specifications listed herein such that no individual component

will be less than specifications for permanent link and channel, regardless of the fact that tests for link and channel ultimately meet required specifications.

J. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.

PART 3 - EXECUTION

3.1 INSTALLATION CONTRACTOR

A. Provide and pay for all labor, supervision, tools, equipment, test equipment, tests and services to provide and install a complete inside and outside plant fiber and copper infrastructure system. Pay all required sales, gross receipts, and other taxes.

B. A BICSI RCDD shall be employed as the Project Manager and approve all on-site work as a recognized member of the Contractor's installation team. All installation team members must demonstrate knowledge and compliance with all BICSI, TIA, UL, and NEC methods, standards and codes.

3.2 EXAMINATION:

A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

B. Established Dimensions: Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

3.3 PREPARATION:

A. Contractor's RCDD Project Manager shall review, approve and stamp all shop drawings, coordination drawings As Built Drawings and submittal documents.

B. Pre-installation inspection

1. The Contractor shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods are not acceptable and shall be replaced by the contractor at no additional cost to the Owner.

3.4 INSTALLATION:

A. General

1. Contractor shall install work following specifications, drawings, manufacturer's instructions and approved submittal data.

2. Allowable Cable Bend Radius and Pull Tension:

a. In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation. Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.
b. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for high performance cable installation.

B. Cable Bundles

1. Bundling of cables is to be avoided; where bundling is necessary bundles shall be limited to no more than 24 cables.
2. Allow cables to lay naturally in cable tray and runways whenever possible.
3. Cables shall be neatly dressed from the point of emergence from vertical cable managers to the point of termination.

C. Pull Strings:

1. Horizontal Cable

a. Provide pull strings in all new conduits, including all conduits with cable installed as part of this contract.
b. Pull string shall have a rated average breaking strength of 200 pounds.
c. Data and video cables can be pulled in tandem with pull strings. During pulling sessions, pull strings must move freely to prevent cable jacket/cable damage.

D. Conduit Fill:

1. Reference manufacturer's Design Installation Guidelines manual.
2. Comply with all applicable Listed Firestop Assembly requirements.

E. Firestop Procedures:

1. Install and seal penetrations (conduit, sleeves, slots, chases) into or through fire-rated barriers created by or made for or on the behalf of the Contractor to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.
2. All through penetrations in a fire rated surface require a sleeve, regardless of penetration diameter or penetrating cable count.
3. Provide listed fire-resistant materials to restore originally-designed fire-ratings to all wall, floor, and ceiling penetrations used in the distribution and installation for communications cabling system. Coordinate firestopping procedures and materials with General Contractor. Following the pathway of others through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.
4. Provide and install intumescent systems in floor chases in an approved fashion in all openings.
5. Shall supply Owner with training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.
6. Provide manufacturer’s UL Listed Assembly Sheet for rated protection for all fire barrier penetrations.
7. Shall laminate and permanently affix adjacent to chases the following information:

a. Manufacturer of firestop system.
b. Date of installation/repair.
c. Listed Assembly number of system.

8. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the General Contractor for written approval of materials/systems prior to purchase and installation.

9. Materials shall be installed per manufacturer instructions, be UL-listed for intended use, and meet NEC and local codes for fire stopping measures.

10. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.

11. Closeout documentation shall include digital photographs of all firestops related to communication cables.

F. Labeling

1. Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

2. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.

3. Contractor shall:

a. Coordinate with Owner correct nomenclature for all labeling.
b. Provide and install transparent plastic label holders, and 4-pair marked colored labels, according to the type of field as per ANSI/TIA-606-B color code designations.
c. Use the ANSI/TIA-606 designation strip color-code guidelines for voice, data, cross-connect, riser, and backbone fields.

G. Site Tests:

1. Upon completion of the communications infrastructure systems, including all pathways and bonding, the Contractor shall test the system.

a. Cables and termination modules/connectors shall be affixed, mounted or installed to the designed/specified permanent location prior to testing. Any removal and reinstallation of any component in the circuit shall require retesting of that circuit.
b. If the Contractor is found to have manipulated any failing test result for any reason (without written notice and approval of the Owner), the Contractor shall be required to employ a Third-Party Testing Agent selected by the Owner to retest the complete cable plant and shall be required to pay all costs associated with this retesting.

2. These specifications will be strictly enforced. The Contractor shall verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing the cable type in use), and documentation as specified below. This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy test data.

3. Notification of the likelihood of a cable exceeding standardized lengths must be made prior to installation of the cable. Without contractor's prior written notice and written approval by the Owner, testing that shows some or all pairs of cable not meeting specifications, shall be replaced at Contractor's expense (including respective connectors).

4. With the Owner's written approval, the over-length cable(s) may be excluded from requirements to pass standardized tests and shall be explicitly identified.

5. Testing is still required for non-compliant cabling. The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to-ground. The test results must be within acceptable tolerances and shall be submitted with the Owner's acceptance document.

6. Third-Party testing of the completed cable infrastructure is an Owner option that can be implemented and completed after (1) all Contractor testing is complete and submitted, and (2) Contractor certifies that cable plant meets or exceeds test result requirements as specified in these and ANSI/TIA test standards. Third-Party testing can be implemented at the Owner's discretion by:

    a. The Owner's preference to independently confirm the submitted Contractor's standards-compliant testing results
    b. Payment of all Third-Party testing shall be by the Owner if the Third-Party testing is requested for confirming Contractor 's complete and standards-compliant test results.
    c. Third-Party shall pick a randomized sample of 15% of total installed cable plant. Prior to testing, this party shall develop and submit a test schedule for approval by Owner.
    d. Third-Party testing processes will adhere to the testing protocols delineated in this document under Section 1.10 and Specification Section 27 08 00
    e. All Third-Party tested cables that test as failed shall be retested by the Third Party to confirm failure.
    f. If Third-Party tests show a failure rate of 2% or greater of tests of all completed cabling, this shall force the retesting of the complete cable plant by the Third-Party at the Contractor's expense.
    g. All confirmed failures shall be promptly corrected and retested by Contractor and Third-Party under the same testing protocols and guidelines.
    h. Payment of all Third-Party testing shall be by Contractor from Contractor's original accepted bid if Third-Party testing is required.
    i. Third-Party shall retest 100% of the total installed cable plant. Prior to testing, this party shall develop and submit a test schedule for approval by Owner.
    j. All Third-Party tested cables that test as failed shall be retested by the Third Party to confirm failure.
    k. All confirmed failures shall be promptly corrected the installing contractor and retested by Third-Party under the same testing protocols and guidelines.
    l. Contractor will complete all work and documentation according to manufacturer guidelines to ensure manufacturer's warranty remains in effect. Contractor shall obtain certificates from manufacturer attesting to

warranty being in effect and include certificates with other deliverables due at the completion of the project.

a. Owner reserves the right to be present during any or all testing.

3.5 CLEANING

A. Work areas will be kept in a broom clean condition throughout the duration of the installation process.

B. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

C. The Contractor will damp clean all surfaces prior to final acceptance by Owner.

3.6 ACCEPTANCE

A. Once all work has been completed, test documentation has been submitted, and Owner is satisfied that all work is in accordance with contract documents, the Owner shall notify Contractor in writing of formal acceptance of the system.

B. Contractor must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).

C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as described herein.

3.7 RE-INSTALLATION

A. No additional burden to Owner regarding costs, network down-time and/or end user interruption shall result from the re-installation of specified components. Scheduling for re-installation work shall be coordinated, in writing, with Owners Representative prior to beginning the work.

3.8 CLOSEOUT ACTIVITIES

A. Contractor shall provide documentation of all communications system components under this section utilized throughout the site for review and reference by Owners Representative and A/E team.

B. Contractor to submit all as-built drawings and test documentation required prior to acceptance by Owners Representative.

C. Issues and deficiencies identified in field reports and punch lists shall have been resolved. Final as-built drawings shall have been submitted, reviewed and found to meet the requirements of the specifications.

D. Contractor shall provide written notice of substantial completion of the telecom infrastructure. Upon receipt, the Owner's Representative will review/observe the completed installation. Once the Owner's Representative is satisfied that all work is in accordance with the Contract Documents, the Contractor will be notified in writing.

E. Contractor's RCDD shall warrant in writing that 100% of the installation meets the requirements of all project specifications.

END OF SECTION

SECTION 27 05 26

COMMUNICATION BONDING AND GROUNDING

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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Telecommunications Busbars

B. Bonding Conductors and Components

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Bonding of all metallic components within ITS spaces, such as, but not limited to, building steel, ladder rack, cable runway, cable tray, racks, cabinets, and conduits.

B. Testing of all bonding connections shall be conducted under the requirements of this specification.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINSTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

2.2 BUSBAR ASSEMBLY:

A. Manufacturer

1. Harger Lightning & Grounding
2. ERICO International Corporation
3. Cooper Industries
4. NO Substitutions Allowed

B. TMGB: 1/4 inch thick by 4 inches high of variable length pre-drilled with TIA standard hole patterns and spacing. Number of required connections determines length of busbar.

C. TGB: 1/4 inch thick by 2 inches high of variable length pre-drilled with TIA standard hole patterns and spacing. Number of required connections determines length of busbar.

D. When Isolated Ground is required:

1. Rack mounted busbar: solid copper busbar 1/8 inch thick by 2 inches wide and threaded 10-32. Varying height

E. Insulators: The busbar shall be insulated from its support.

F. Wall mounting brackets shall provide a minimum 2" separation from the wall to the back of the busbar

G. Busbars shall be UL Listed as bonding and grounding equipment.

2.3 BONDING CONDUCTORS AND COMPONENTS

A. Manufacturer

1. USA Wire and Cable
2. CERRO
3. Southwire
4. Harger
5. Burndy
6. Cooper Industries

B. Copper Bonding Conductors

1. Bare or Insulated and green in color
2. Sized in accordance with TIA-607-B (2 kcmil per linear foot of conductor length)
3. Minimum size bonding conductor shall be 6 AWG
4. Maximum size bonding conductor shall be 3/0 AWG
    a. For example: A conductor 25 feet in length shall be 2 AWG (66,360 cmil)
    b. A bonding conductor 100 feet in length shall be 3/0 AWG
5. Insulation shall be rated for the environment in which installed.

C. Bolt-On Connector Lugs

1. Lugs for connecting to the TMGB and TGB shall be UL Listed two-hole, long barrel, electro tin-plated compression lugs with inspection port.

2. Compression lugs shall have two holes spaced on 5/8 inch (15.8 mm) or 1 inch (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 3/0, as stated below.
4. Antioxidant joint compound, shall be applied as required to the contact areas.
5. Lugs shall be secured to the ground bars with ¼" minimum stainless steel hex head cap screws with stainless steel washers, lock washers and nuts.

D. Exothermic Welded Connections

1. Exothermic Welded connections shall be Ultraweld by Harger.
2. Weld types BE shall be made to the ground bars using appropriate size weld metal.
3. Weld types VA, VD, or VU shall be made to structural steel framework

E. Shield Bond Connector

1. Shield bonding assembly, with base and top members made of tin-plated tempered brass, slightly curved to exert a continuous spring force on sheath and shield after clamping, and two securing lock nuts. Designed to make a stable, low resistance electrical connection between the shield of a communications cable and a bonding conductor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 INSTALLATION

A. Wall-Mount Busbars

1. The telecommunications main grounding bar (TMGB) is a dedicated extension of the building grounding electrode system for the telecommunications system. The TMGB should be located near the telecommunications service entrance and the electric service entrance in the MPOE. All other spaces shall have a TGB.
2. Only One (1) busbar shall be installed in any space.
3. All Telecommunications Busbars shall be mounted above the cable runway in the space they serve.
4. Busbars shall be located to minimize the length of bonding conductors within the telecommunications space.
5. Attach busbars to the wall with appropriate hardware per the manufacturer's installation instructions.
6. Each lug shall be attached with stainless steel hardware after preparing the bond per manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
7. Each wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.

B. Racks and Cabinets

1. Every rack and cabinet shall be bonded to the closest T(M)GB.
2. Minimum bonding connection to racks and cabinets shall be made with an irreversible 2-hole lug sized to fit the conductor and rack and installed per ANSI/NECA/BICSI 607-2011, BICSI Best Practices, and manufacturer recommendations.
3. Remove paint between rack/cabinet and bonding lug, clean surface and use antioxidant between the rack and the bonding lug to help prevent corrosion at the bond.

C. Bonding to Structural Steel of a Building

1. All bonding conductors and connectors for bonding the metal frame of a building shall be listed for the purpose intended by a NRTL.
2. In buildings where metal frames (structural steel) are effectively grounded, each T(M)GB shall be bonded to the structural steel within the room using a properly sized bonding conductor and connection method.
3. Connections to the structural steel frame shall be made by exothermic welding or by Harger No. 217 or Harger No. 223T electro tin-plated bronze bonding plates. The area of contact on the steel frame shall be cleaned to bare metal removing all paint and mill scale. The contact area shall be protected from corrosion using Harger series HAAJC antioxidant joint compound.
4. Where the structural steel is external to the room and readily accessible the structural steel shall be bonded to the T(M)GB with a properly sized bonding conductor.
5. Steel bars of a reinforced concrete building are not required to be bonded to the T(M)GB.

D. Conduits and Cable Trays

1. All metal conduits and raceways for telecommunications cabling located within the telecommunications space as the busbar shall be bonded to the busbar.
2. Metal cable trays shall be bonded to the busbar.

E. Telecommunications Backbone (TBB)

1. The telecommunications backbone (TBB) is a conductor that originates at the TMGB and extends throughout the building interconnecting all telecommunications grounding busbars (TGBs) with the TMGB.
2. The TBB shall be a copper conductor. The minimum size of the conductor shall be 6 AWG. The size of the conductor shall be increased 2 kcmil per linear foot as the length of the TBB increases to a maximum of 3/0 AWG. For example: A TBB 25 feet in length shall be 2 AWG (66,360 cmil). A TBB 100 feet in length shall be 3/0 AWG.
3. The TBB conductors should be installed without splices. Where splices are necessary, the number of splices should be minimized and located in accessible telecommunications spaces. Splices shall be made using exothermic welding, listed irreversible compression connectors or equivalent.
4. The building water piping system shall not be used as a TBB.
5. Metallic cable shields or metallic conduits shall not be used as a TBB.
6. The TBB shall not rely on connections to any TGB for continuity to another TGB.

F. Grounding Equalizer (GE)

1. Where there are multiple telecommunications rooms or spaces with multiple TBBs, the TBBs shall be interconnected with a Grounding Equalizer (GE) conductor at the TGBs.
2. The GE shall be sized as specified for the TBB.
3. Connections of the GE to the TGBs shall be made by exothermic welding or by listed two-hole compression lugs.

G. Shield Bond Connector Installation

1. The Contractor shall provide a shield bond connector to the shield of each fiber optic and copper riser cable in order to make a stable, low-resistance connections between the shield and a bonding conductor.
2. The bonding jumper at the shield bond connector end shall have a single hole standard barrel lug with a 6 AWG conductor. The other end of the bonding jumper shall be a 2-hole long barrel compression for bonding at the T(M)GB.

H. Testing

1. The Telecommunications Bonding and Grounding System shall be tested with an Earth Ground Resistance Tester using the Two Point Test Method.
2. The following shall be required to test the bonding and grounding.
    a. An Earth Ground Resistance Tester with the attachments.
    b. All testing should be done with the entire building in operation. Nothing needs to be shut down to test the bonding and grounding with this tester.
    c. If the resistance value is less than 0.1 Ohm between the two test points the bonding is adequate.
3. Tests to be conducted:
    a. The installer / technician conducting these tests must be certified
    b. Test between the TMGB and the service equipment (power) ground.
    c. Test between the TMGB and each TGB in the system.
    d. Test between the TGB and:
        1) Data racks
        2) Cable tray
        3) Telecommunication conduit
        4) Caging
        5) Electronic equipment
4. Tests shall be conducted with the systems in operation.
5. Tests shall be recorded and submitted to the Owner's Representative.

3.3 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART 3.7

3.4 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART 3.8

END OF SECTION

SECTION 27 05 28

COMMUNICATION PATHWAYS

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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Cable Pathway Systems

B. Sleeves for Pathways and Cables

C. Backbone Cable Routing

D. Horizontal Cable Routing

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. This section includes the minimum requirements for communications cable pathway installations.

1. Backbone Cable Routing
2. Horizontal Cable Routing
3. Products
4. Common Requirements for Communications Installations
5. Separation from EMI Sources
6. Sleeve Installation for Communications Penetrations
7. Penetration of Building Surfaces
8. Cutting and Patching
9. Retrofit-Cutover

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

1. No Substitution without pre-approval

2.2 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: EMT with plastic bushings, or as required to meet UL Listed firestop assembly requirements.

B. Sleeves shall not extend more than six (6) inches from penetrated barrier surface.

2.3 FIRESTOPPING

A. Subject to compliance with requirements, provide products of one of the following manufacturers:

1. Hilti Firestop Systems
2. 3M, Electrical Products Division
3. Specified Technologies Inc

B. Provide materials classified by UL to provide fire barrier equal to time rating of construction being penetrated.

C. Provide asbestos free materials that comply with applicable Codes and have been tested in accordance with UL 1479 or ASTM E 814.

D. Fire Rated Cable Pathways: Device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:

1. Specified Technologies Inc. (STI) EZ-PATH™ fire rated pathway

E. Or equivalent product from different manufacturer, after approval by owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 BACKBONE CABLE ROUTING

A. Adequate riser sleeve/slot space shall be available with the ability to ingress the area at a later date in all telecommunications rooms, such that no drilling of additional sleeves/slots are necessary.

B. The backbone cables shall be installed in a star topology, emanating from the main cross-connect to each telecommunications room. An intermediate cross-connect may be present between the main cross-connect and the horizontal cross-connect.

C. Backbone pathways shall be installed or selected such that the minimum bend radius and pulling tension of backbone cables is kept within cable manufacturer specifications both during and after installation.

3.3 HORIZONTAL CABLE ROUTING

A. All horizontal cables shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.

B. Cable Bundles

1. Bundling of cables is to be avoided; where bundling is necessary bundles shall be limited to no more than 24 cables.

2. Allow cables to lay naturally in cable tray and runways whenever possible.

3. Cables shall be neatly dressed from the point of emergence from vertical cable managers to the point of termination.

C. Consolidation points shall not be used.

D. Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.

E. In ACT type ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 m (5 ft) apart.

F. For voice or data applications, 4-pair copper balanced twisted-pair cables shall be run using a star topology from the telecommunications room serving that floor to every individual information outlet. The Owner prior to installation of the cabling shall approve all cable routes.

G. The Contractor shall observe the bend radius and pulling strength requirements of the 4 pair copper balanced twisted-pair optic cable during handling and installation.

H. Each run of 4-pair copper twisted-pair cable between horizontal portions of the cross-connect in the telecommunication closet and the information outlet shall not contain splices.

I. In an ACT type ceiling environment, a minimum of 75 mm (3 in) shall be observed between the cable supports and the ACT.

J. Continuous conduit runs installed by the contractor should not exceed 30.5 m (100 ft) or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.

K. All horizontal pathways shall be designed, installed and grounded to meet applicable local and national building and electrical codes.

L. The number of horizontal cables placed in a cable support or pathway shall be limited to a number of cables that will not cause a geometric shape of the cables to be altered. Under no circumstances should cables in the horizontal pathway be bundled. This is to minimize “alien” cross talk.

M. Maximum conduit pathway capacity shall not exceed a 40 percent fill. However, perimeter and furniture fill ratio is limited to 60% fill for moves, adds, and changes.

1. Horizontal distribution cables shall not be exposed in the work area or other locations with public access.

3.4 SEPARATION FROM EMI SOURCES:

A. Comply with TIAEIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

B. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
3. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

C. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
3. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

D. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

1. Electrical Equipment Rating Less Than 2 kVA: No requirement.
2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
3. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

E. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or higher: A minimum of 48 inches.

F. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate framed wall assemblies, concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Each pipe sleeve, horizontal or vertical, shall have a plastic type “end-bushing” on both ends to protect cables from abrasion when pulled through sleeves. The “end-bushing” shall be installed prior to install cables through sleeve.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls with respect to plastic “end-bushings”. The plastic “end-bushing” shall be plenum rated if applied in plenum space.

G. Extend sleeves installed in floors 2 inches above finished floor level with respect to plastic “end-bushings”. The plastic “end-bushing” shall be plenum rated if applied in plenum space.

H. Size pipe sleeves to provide ¼-inch annular clear space between sleeve and pathway or cable, unless indicated otherwise.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Weather seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

C. Provide sleeves for new conduit and cable penetrations of building construction.

1. Openings to accept sleeves in new building construction will be formed in building construction by the Contractor for General Construction work. Openings to accept sleeves in existing building construction shall be provided under this division of the Specifications. Refer to, CUTTING AND PATCHING in this Section.

2. Use galvanized rigid conduit sleeves for penetrations through exterior masonry/concrete walls and foundations, concrete floor slabs on grade and above grade, and concrete-filled decks.

3. Use only fire-rated listed assemblies for the type of sleeve being installed through CMU walls or gypsum walls for communications penetrations. Sleeve type shall be galvanized rigid conduit.

D. Where conduits are installed before building construction being penetrated, install sleeves loose around conduits. Split, fit, and weld steel sleeves over existing conduits, with respect to anything flammable in the surrounding environment.

E. Secure sleeves firmly in place using filling and patching materials (grout) that match with surrounding construction.

F. In floor penetrations, extend sleeve 4 inches above finished floor unless noted otherwise. In wall penetrations, cut sleeves flush with wall surface and use metal escutcheon plates in finished interior areas.

G. Seal voids between sleeves and building construction with joint sealants. Make allowances for and coordinate the Work with installation of firestopping, conduit insulation, and waterproofing as applicable.

H. The Contractor shall be fully responsible for final and correct location of sleeves. Sleeves which are omitted or incorrectly located in existing building construction, shall be corrected and provided by the Communications Contractor, at no additional costs to the Owner.

3.7 PENETRATION OF BUILDING SURFACES

A. Above Grade Level or Non-waterproof Areas

1. Seal each annular space between conduits or cable and building surfaces. Pack space with oakum, other rope packing, or backer rod materials and cover with fire-resistant sealantor other protection materials.

2. Provide sleeves as specified in article, sleeve-seal installation in this section for conduit and cable penetrations. Seal each space between conduit or cable and sleeve. Sealing shall be as specified in above paragraph.

B. Waterproof areas (above and below grade)

1. In new and existing construction for penetrations through concrete below grade, ground water level, or in other waterproof areas, provide through-wall and floor seals having galvanized fittings, sealing assemblies, and sleeves as specified.

2. In existing construction when core bore drilled openings are used for conduit penetrations below grade, ground water level, or in other waterproof areas, provide sealing.

C. Fire-resistant areas

1. Provide through-penetration firestop systems for penetrations through fire-rated walls, floors, and other partitions of building construction. Comply with requirements in division 07 section "penetration firestopping".

2. In walls or partitions with 2-hour or less fire ratings, provide only metallic outlet or device boxes installed per UL fire resistance director, NEC, and other national building code requirements.

3.8 CUTTING AND PATCHING

A. Provide openings, cutting, coring, and patching of openings in existing building construction as required. Patching includes openings and voids left in existing construction as a result of demolition.

B. The Work shall include necessary assemblies and materials to maintain required fire ratings.

C. Perform cutting as to not impair structural stability of building construction and systems. Do not drill holes or weld attachments to beams and other structural members without prior written approval from the Owner's Representative. Contact the Engineer-of-Record for guidance.

D. The Work shall be done by a craftsperson skilled in the particular trades affected.

E. Patching materials shall match existing materials in type and quality. Patching shall be done in a manner to match appearance of adjacent surfaces.

3.9 RETROFIT-CUTOVER

A. Furnish equipment, materials, labor and services, and perform operations required to retrofit/cutover existing cabling systems. Removals shown are general indications and may not indicate full extent of removals which may be required to complete Work.

B. Furnish equipment, materials, labor and services, and performing operations required to enable continued functioning of existing system until cutover to new system.

C. Remove wiring, punch blocks, cabinets, outlets, raceways, and equipment not required for new system.

1. Abandon flush mounted device and junction boxes and cover with blank plate to match the current room decor.

2. Remove surface telecommunications outlets and pathways unless said removal will damage the existing finish on surfaces, or physically damage the structure.

3. Remove wiring from abandoned conduits and raceways from the work area outlet back to the corresponding termination point in the telecommunication room. Place a trailer string in vacated conduits and raceways.

4. Remove labeling at both ends for abandoned cables/wiring.

5. The collected abandoned cables/wiring shall be collected and removed from site by contractor.

D. Perform the work in neat and workmanlike manner in accordance with the applicable codes, standards and AHJ.

E. Removal and replacement of existing ceilings:

1. Carefully remove existing ceilings as required to perform the work. Store removed tiles in an area designated by the owner. Modify and augment existing suspension systems as necessary. Restore ceiling systems to their original finish.

2. Repair any damage to ceilings due to modifications, removal, and replacement of same. Replace damaged ceiling tiles, including tiles with holes or openings left as a result of demolition, with materials of like kind.

F. Existing equipment or material shall not be reused without specific approval of the Owner's Representative except as noted below:

1. Existing cable terminal housings may be reused if in good condition.

G. Equipment and materials to be removed and not desired by the Owner shall be removed from site promptly.

H. Equipment and material to be removed and that is desired by the Owner shall be moved to an on-site storage location as directed by the Owner.

3.10 FIRESTOPPING

A. Performance Requirements

1. Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur.

2. Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.

3. Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.

4. Openings for cable trays shall be sealed using re-enterable firestopping pillows.

B. Quality Assurance

1. Products/systems: provide firestopping systems that comply with the following requirements:
2. Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
3. Firestopping products bear the classification marking of qualified testing and inspection agency.
4. Installer qualifications: experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

C. Project Conditions

1. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
2. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
3. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
4. Do not use materials that contain flammable solvents.
5. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
6. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
7. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

3.11 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART 3.7

3.12 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART 3.8

END OF SECTION

SECTION 27 05 33

COMMUNICATION CONDUITS AND BOXES

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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Telecom conduits and boxes.

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for conduit pathways, back boxes and pull box enclosures utilized for the distribution and housing of telecommunications cabling and components:

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

1. No Substitution without pre-approval

2.2 TELECOM CONDUITS AND BOXES

A. Conduit

1. UL Listed of domestic manufacture

B. Pull boxes

1. UL Listed of domestic manufacture

C. Back Boxes

1. Randl
2. Siemon

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 TELECOM CONDUITS AND BOXES

A. Pull Boxes:

1. Install Pull boxes in easily accessible locations.
2. Install Horizontal cabling boxes minimum 6” above suspended ceilings.
3. A pull box should not be used in lieu of a bend.
4. Conduits that enter the pull box from opposite ends with each other should be aligned.
5. For direct access to a box located above inaccessible ceilings provide a suitable, marked, hinged access panel (or equivalent) in the ceiling. This access panel can also serve as the cover for the box.
6. Pull box sizing table:

Conduit Trade Size (in.)	Pull Box Width (in.)	Pull Box Length (in.)	Pull Box Depth (in.)	Pull Box Width Increase for Additional Conduit (in.)
1	4	16	3	2
1 1/4	6	20	3	3
1 1/2	8	27	4	4
2	8	36	4	5
2 1/2	10	42	5	6
3	12	48	5	6
3 1/2	12	54	6	6
4	15	60	8	8

B. Back Boxes:

1. Provide 5” H X 5” W X 2-7/8” D outlet back boxes with integrated cable management at all telecom outlet locations shown on drawings.
2. Provide (1) 1-1/4” conduit from back box to telecom cable tray, except as otherwise noted.
3. Provide single gang plaster/mud ring on all communications outlet back boxes, unless indicated otherwise in the contract drawings.

4. Provide bonding to cable pathways.

C. Conduit Support and Bracing:

1. Coordinate layout and installation of conduits and pull boxes with other trade conditions to ensure adequate clearances, access and cable management.

2. Provide seismic support and bracing for all conduits and pull boxes installed under work of this project per the project's structural requirements. Any proposed reinforcement is the responsibility of the Contractor.

3. Coordinate seismic design with architectural, structural, mechanical, electrical, plumbing, fire protection, and other trades.

4. Structural braces and/or reinforcements are to be attached directly to structural framework and secondary structural members; do not attach braces and/or reinforcements to elements other than structural framework and secondary structural members.

5. Install and provide support for conduits and pull boxes in accordance with the latest edition of the NEC, as well as all state and local codes and requirements. Coordinate installation and location with existing conditions.

6. Install conduits above ceilings at height to provide access to pull boxes and cable access to where conduits terminate to meet up with cable trays. Install conduits and pull boxes level and square and at proper elevations. Ensure adequate clearances, access and cable management.

7. Supporting devices: U channel trapeze assemblies, 3/8" threaded rods, clamps, conduit straps, C-clamps and retainers.

8. Fasteners: Carbon steel expansion anchors with minimum 3" embed into concrete slab for pull box U-channel support attachment. The anchors must be tested and approved under dual load conditions.

9. U-channel systems: 16 gauge steel channels. Provide fittings and accessories that match with the U-channel of the same manufacturer.

10. Use fittings and support devices compatible with conduits and pull boxes and suitable for use and location.

11. Install individual and multiple trapeze hangers and riser clamps as necessary to support the conduits. Provide U-bolts, clamp attachments and other necessary hardware for hanger assemblies and for securing hanger rods and conduits. Space supports for conduits on maximum 10-foot centers.

12. Provide and install expansion or deflection fittings for conduits runs at all instances of seismic or expansion joints to allow for movement in any direction.

D. Conduit Routing, Bends and Radius Guidelines:

1. If the conduit has an internal diameter of 2 inches or less the bend radius must be at least 6 times the internal conduit diameter.

2. If the conduit has an internal diameter of more than 2 inches the bend radius must be at least 10 times the internal conduit diameter.

3. Conduit bends should be smooth, even, and free of kinks or other discontinuities that may have detrimental effects on pulling tension or cable integrity during or after installation.

4. If a conduit run requires more than two 90 degree bends then provide a pull box between sections with two bends or less.
5. If a conduit run requires a reverse bend (between 100 degrees and 180 degrees) then insert a pull point or pull box at each bend having an angle from 100 degrees to 180 degrees.
6. Consider an offset as equivalent to a 90 degree bend.
7. Achieve the best direct route with no bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.
8. Contain no continuous sections longer than 100 ft.
9. For runs that total more than 100 ft. in length, pull points or pull boxes should be inserted so that no segment between points/boxes exceeds the 100 ft. limit.
10. Withstand the environment to which they will be exposed.
11. Conduits shall not be routed through areas in which flammable material may be stored or over or adjacent to boilers, incinerators, hot-water lines and steam lines.
12. Maintain 6" separation from parallel runs of steam, hot water pipes or mechanical ductwork so as not to affect cable performance.

E. Conduit Terminations:

1. Join conduits with fittings designed and approved for the purpose. Make the joints tight without protrusions that may damage cable inside the conduits.
2. Where conduits are terminated with locknuts and bushings align the conduit to enter squarely and install the locknuts with dished part against the box. Use two locknuts, one inside and one outside the box.
3. Ream all conduit ends and fit them with an insulated bushing, connector, or coupling to eliminate sharp edges that can damage cables during installation or service.
4. Conduits that enter a telecom room should terminate near the corners to allow for proper cable racking.
5. Terminate conduits that protrude through the structural floor 3 inches above the surface.
6. Maintain the integrity of all fire stop barriers for all floor and wall penetrations.
7. Provide bonding for conduits and pull boxes as indicated by the NEC, ANSI/NECA/BICSI 607-2011, and as instructed by manufacturer.
8. Conduits shall be clearly labeled at both ends designating the opposite locations(s) served. The numbering scheme shall be room number plus a suffix to guarantee uniqueness, e.g., 143-1. Labeling must be machine generated.

F. Conduit Protection:

1. Remove burrs, dirt and construction debris from conduits and pull boxes.
2. Conduits should be left capped for protection.
3. Provide final protection and maintain conditions in a manner acceptable to the Owner's Representative to ensure that coatings, finishes and pull boxes are without damage or deterioration at completion. Repair damage to galvanized finishes with zinc-rich paint recommended by the manufacturer.

3.3 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART 3.7

3.4 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART 3.8

END OF SECTION

SECTION 27 05 53

COMMUNICATION IDENTIFICATION

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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Labeling and identification.

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications information for identification of the various components of the telecommunications infrastructure and pathway system.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

2.2 LABELING AND IDENTIFICATION

A. Manufacturer List:

1. Panduit thermal transfer printer.

2. Brady labeling system.

B. Description:

1. All labels shall be machine-manufactured. Handwritten labels shall not be accepted for final labeling.
2. The intention of the labeling scheme is to be ANSI/TIA-606-B compliant.
3. It is the responsibility of the contractor to acquire, understand, and utilize Owners Representative's labeling scheme for all components of the voice data communications system.
4. It is the responsibility of the contractor to provide labels sized to show Owner's labeling scheme in readable font size while still matching the specified hardware identification dimensions.

C. Indoor Copper and Fiber Optic Cables and Bonding Conductors:

1. The cable sheaths shall be labeled with machine-printed polyester self-laminating wrap-around labels sized to fit Owner's labeling scheme in readable font size.

D. Outside Plant Copper and Fiber Optic Cables:

1. The cable sheaths shall be labeled with non-adhesive thermal transfer marker plates attached to the cables with nylon cable ties. The marker plates shall withstand harsh solvents, oils, and chemicals without over-lamination. Marker plates shall offer crisp, clear legends with superior legibility when printed on a thermal transfer desktop printer utilizing the resin ribbon designated for use and shall meet requirements for MIL-STD-202G, Notice 12 Method 215J sized to fit Owner's labeling scheme in readable font size.

E. Horizontal Cable Outlet Housings and Faceplates:

1. Cable termination connectors at each position on the outlet housing shall be labeled with laser-printed labels inserted into the outlet housing labeling window.

F. Copper Patch Panels:

1. The patch panels shall be labeled on the front and rear top left corner with a laser-printed polyester self-laminating label sequentially identifying the patch panel.

G. Copper Patch Termination Blocks:

1. The termination blocks shall be labeled on the front rows with the termination block designation strip colored per ANSI/TIA-606-B requirements identifying the copper cable pairs.

H. Fiber Optic Termination Panels and Housings (FDU):

1. The panels and housings shall be labeled on the outside front and rear top left corner with a laser-printed polyester self-laminating label sequentially identifying the panel.
2. Cable termination identifier and fiber positions inside the termination panels shall be made using the manufacturer's provided label card behind the plastic panel.

I. Equipment Racks

1. Metal Card Holder bracket attached to rack to runway support bracket. NorCal Metal Fabricators Part no. NC-D1185-11. Or equal.
2. Metal Card Holder (2"W x 12.75"L): NorCal Metal Fabricators Part no. NC-D1180-1.
3. Label card: NorCal Metal Fabricators Part no. NC-D1180-2.
4. Clear plastic cover: NorCal Metal Fabricators Part no. NC-D1180-3.

5. Or equal

J. Equipment Cabinets:

1. Reflective Lettering System Labels shall be adhesive backed individual letters and numbers. Dimension per individual label is 1 ½" X 1". 3M Scotchlite 5005 Reflective Lettering System. Or equal.

2. Individual letters and numbers shall be compiled to match identification for each rack or cabinet location and shall be placed on a Decal Strip Holder attached to front and rear of each equipment rack or cabinet. 3M 5012L Decal Strip Holder. Or equal.

K. Indoor Pull Boxes:

1. Each pullbox shall be labeled on the outside door panel facing and unobstructed view with a reflective lettering system. Labels shall be adhesive backed individual letters and numbers.

2. Dimension per individual label is 1 ½" X 1". 3M Scotchlite 5005 Reflective Lettering System. Or equal.

L. Outdoor Enclosures:

1. Each wall mounted enclosure shall be identified with its individual identifier at the top right of the enclosure door. The Lettering is 1 inch tall solid two colored injection molded letters held in an aluminum tag/letter holder. The aluminum tag/letter holder shall be attached to the enclosure with appropriate fasteners.

2. AH106 Aluminum tag/letter holder and ELHWK 1 inch tall white on black injection molded letters : Everlast, Makers and Tags, Tech Products, Inc.

3. Or equal, no known equal.

M. Conduit Labeling

1. All conduits smaller than 3" shall be labeled within 12" of termination with a laser-printed polyester self-laminating label sequentially identifying the conduit and its origin and termination end (to and from).

2. All 3" and larger conduits shall be labeled with a stainless steel marker tag.

3. Stainless steel marker tag shall be machine embossed with a labeling scheme approved by Owners Representative.

4. Stainless steel marker tag shall be secured with stainless steel tie wraps.

5. Marker tags shall be located at each penetration through a wall or floor, and at 50 ft.' intervals on continuous runs.

6. Stainless steel marker tags shall be Panduit MMP350-C316, or equal.

7. Stainless steel tie wraps shall be Panduit MLT-S, or equal.

N. Outside Plant Conduits and Pull Boxes/Manholes/Vaults:

1. Each OSP conduit shall be labeled on the inside of the pull box, manhole or vault with a non-adhesive thermal transfer marker plates attached to the pull box, manhole or vault with mechanical fasteners. The marker plates shall withstand harsh solvents, oils, and chemicals without over-lamination. Marker plates shall offer crisp, clear legends with superior legibility when printed on a thermal transfer desktop printer utilizing the resin ribbon designated for use and shall meet requirements for MIL-STD-202G, Notice 12 Method

215J sized to fit Owners Representative's labeling scheme in readable font size, sequentially identifying the conduit and its origin and termination end (to and from).

2. Each pull box/manhole/vault shall be identified on the cover plate/lid sequentially identifying the pull box/manhole/vault.

PART 3 - EXECUTION

3.1 LABELING

A. The labeling scheme is intended to comply with ANSI/TIA-606-B standard for labeling and administration of a cable plant. It is the responsibility of the contractor to acquire, understand, and utilize the Owner labeling scheme for all component of the voice data communications systems including, but not limited to:

1. Indoor Horizontal copper and fiber optic cables (Identify at both ends within 6-inches of termination)
2. Indoor copper and fiber optic backbone cables shall be identified at both ends within 12-inches of the point that the cable enters or exits termination panels/blocks, pull boxes, wall and floor sleeves.
3. Outside plant copper and fiber optic backbone cables shall be identified at both ends within 12-inches of the point that the cable enters or exits termination panels/blocks, pull boxes, manholes, vaults and pedestals.
4. Workstation outlets, faceplates and individual outlet connectors.
5. Termination panels and blocks.
6. Racks, cabinets, and equipment enclosures. (front and rear)
7. Indoor and OSP conduit pathways, pull boxes, manholes, and vaults.
8. Bonding conductors and busbars.
9. Label each component with a specified label at an unobstructed view location and where it is accessible for administration.

3.2 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.3 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART 3.7

3.4 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART 3.8

END OF SECTION

SECTION 27 08 00

COMMUNICATION COMMISSIONING

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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Copper cable test device

B. Optical fiber test device

C. Coaxial cable test device

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for a certification tester used for end to end testing, certification, and documentation of all test results to confirm the installed connectivity system complies with industry standards and specific category and performance ratings.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1. Electronic Reports: Submit in CD format. Include necessary software required to view test results. Accompany electronic reports by Certificate signed by authorized representative of Contractor warranting truth and accuracy of electronic report. Certificate: Reference traceable circuit numbers that match electronic record. Contain following information on each row of report: Circuit ID, test specification used, length, date of test, and pass/fail results.

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

1. No Substitution without pre-approval

2.2 COPPER CABLE TESTER

A. Manufacturer List:

1. Fluke
2. Agilent

B. Description:

1. Must meet or exceed TIA Level IV compliant network cable-testing device certification by an independent laboratory, such as Intertek, for verification of high performance cables.
2. Copper test equipment must be capable of certifying Category-3, Category-5e, Category-6 and Category-6A UTP and F/UTP links or channels independent of termination hardware configuration (8P8C port or 110-style) for each level of performance.
3. Provide full 2-way Autotest of Category-3, 5E, 6 and 6A twisted pair links.
4. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

C. Accessory Products:

1. Interface Adapters
2. Category/Class E permanent link adapters for TIA unshielded and shielded cables.
3. DTX ten (10) Gigabit Kit

2.3 OPTICAL FIBER TESTER

A. Manufacturer List:

1. Fluke
2. Agilent

B. Product Options:

1. Select analyzer to comprehensively certify each optical fiber connection and record results verifying compliance with TIA/EIA performance standards and manufacturer specifications.
2. Tier 2 OptiFiber or Equal Certifying OTDR

C. Description:

1. The optical fiber source shall permit full end to end testing of Multimode, Single-mode and LOMMF optical fiber cabling fully compliant with industry standards and manufacturer recommendations.
2. Available source types and wavelengths shall be as follows:
   a. Multimode - 850nm LED and 1300nm LED.
   b. Single-mode – 1310nm FP Laser and 1550nm FP Laser.

c. LOMMF – 850nm VCSEL and 1310nm FP Laser.

3. The built in power meter shall be calibrated to read 850, 1310 and 1550nm wavelengths.

4. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

D. Accessory Products:

1. Interface Adapters

a. Fiber Modules including Multimode, Single-mode and LOMMF adapters.

b. Optical Fiber Mandrels.

2.4 COAXIAL CABLE TESTER

A. Manufacturer List:

1. Fluke

2. Agilent

B. Product Options

1. Select analyzer to comprehensively Autotest each connection and record results verifying compliance with industry standards and manufacturer specifications.

a. DTX or Equal Digital Cable Analyzer

C. Description

1. The tester's Autotest function shall test and record cable resistance, length, impedance, insertion loss and propagation delay. Additionally the tester shall provide a TDR function that provides extended troubleshooting capabilities.

2. All test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

D. Accessory Products:

1. Interface Adapters

a. DTX-Coax Interface Adapters

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

B. Verify telecommunications cabling is installed and supported, terminated, mounted in an appropriate housing or terminated on the applicable component and labeled prior to certification testing and documentation.

C. Verify certification tester universal interface adapters and manufacturer patch cords that enable permanent link verification are in new condition not indicating any twisting or kinking resulting from incorrect storage of the tester interface adapters.

D. Optical fiber patch cords shall be inspected to ensure connector surfaces are clean and free of defects that may affect testing results.

E. Refer to Section 01 91 00 - General Commissioning Requirements.

F. Refer to Section 27 00 00 – 3.4 and 3.6 for additional requirements.

3.2 TEST INSTRUMENT SUBMITTALS

A. All copper & fiber optic test instruments used on the site shall be capable of storing test data files and downloading these test results as data files. The unique cable/strand number previously approved as per Specification 27 05 53 shall be used as the record identifier for each test.

B. Submit a certificate verifying the model number, serial number, manufacturer, last date of calibration/certification for each test instrument used on the site prior to any testing.

3.3 TEST AND EVALUATION REPORTS:

A. Prior to commencement of full system testing a test sample shall be submitted to Owner's Representative in order to verify correct testing procedures.

1. Sample test reports shall include:

a. Copper tests for one (1) complete 48 port patch panel

b. Optical Fiber tests for 24 consecutive MMF strands

c. Optical Fiber tests for 24 consecutive SMF strands

2. These reports shall be reviewed and accepted by Owner's Representative prior to any additional testing.

3. Should the contractor fail to provide sample test reports prior to full system testing and issues are found with submitted test reports, full retesting of installed cable plant shall be required at the contractors expense.

B. A complete set of test results verifying the installed link performance parameter results for all cable types shall be presented to the Owner's Representative at least two (2) weeks before the placement of any active electronics in technology rooms and/or spaces.

C. Verification and test results in electronic format saved directly from the testing device software application. Results must be neatly presented and organized according to floor and cable type; OSP, ISP, Category-6A, Category-3, and optical fiber cables (backbone and workstation fiber) must be divided into separate sections for each floor. Electronic results shall be presented in the testing device's native file type with a copy of the electronic software used to generate the test results when requested.

3.4 OPTICAL FIBER CABLE TESTING

A. Fiber Testing: Perform on fibers in completed end to end system. Splices not allowed unless clearly defined and pre-approved by Owner's Representative.

1. Testing: Bi-directional end to end power meter test, TIA/EIA 455-53A.

2. Test horizontal multimode fiber at both 850nm and 1300nm, TIA-526-14-A OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant - Method B, (1 Jumper Reference)

a. The following loss limits shall apply to Horizontal segments regardless of actual link configuration:

1) Permanent Link 2.0 dB

2) Permanent Link w/ CP 2.8dB

3) Permanent Link w/MUTOA 2.0 dB

4) Centralized Fiber 3.3 dB

5) Centralized Fiber w/ CP 3.3 dB

3. Test backbone multimode fiber at both 850nm and 1300nm, TIA-526-14-A OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant - Method A, (2 Jumper Reference)

4. Test all single-mode fiber at both 1310 nm and 1550 nm, TIA/EIA 526-7 OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant - Method A.2 (2 Jumper Reference)

B. Pre-installation Cable Testing: Test fiber optic cable prior to installation of cable.

1. Contractor shall be solely responsible for replacement of cable if found defective at later date.

C. Loss Budget – Backbone Fiber Links: Maximum loss of:

1. (Allowable cable loss per km)*(km's of fiber in link) + (.5dB)*(number of connector pairs) + (.15dB)*(number of splices) = maximum allowable loss

2. Splice Losses from Fusion Splice Pigtail Connectors and Fusion Splice-On Connectors shall not be counted in the Loss Budget. Only the Connector Loss shall be counted for Loss Budget.

3. All test reports exhibiting a Headroom Margin of 0.25 dB or less shall be considered as not meeting requirements of this specification.

4. Bring links not meeting requirements of this specification into compliance, at no charge to Owner.

D. Documentation: Provide native electronic test reports to point of contact, include required software to view electronic results.

3.5 COPPER AND COAXIAL CABLE TESTING

A. Certification test 100% of the installed cabling plant including all backbone and horizontal four (4) pair copper, multi-pair UTP and coaxial connections.

B. Follow manufacturers' instructions and recommended industry standards and guidelines to complete all TIA/EIA testing procedures to verify performance levels.

C. Follow manufacturer requirements for self-calibration procedures.

D. Update tester software to show specific project information including but not limited to:

1. Date and time of testing

2. Project name

3. Field technicians name

4. Cable identification number

5. Cable manufacturer, type and part number

E. REPAIR

1. Any connections failing to meet referenced standards or more stringent performance requirements stated above, must be removed and replaced with connections that prove, in additional testing, to meet or exceed the performance standards set forth.
2. Refer to Section 01 91 00 - General Commissioning Requirements.

3.6 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART 3.7

3.7 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART 3.8

END OF SECTION

SECTION 27 11 19

COMMUNICATION TERMINATION BLOCKS AND PATCH PANELS

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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Copper horizontal cabling UTP Patch Panels.

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for wall and rack/cabinet-mounted blocks, termination panels and patch panel components utilized to terminate various telecommunications infrastructure cabling and connectivity.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

1. No Substitution without pre-approval

2.2 COPPER HORIZONTAL CABLING UTP PATCH PANELS

A. Manufacturer List:

1. Ortronics Category-6 UTP
2. Leviton Category-6 UTP

3. Belden Category-6 UTP

B. Description:

1. All patch panels are to be rack/cabinet mountable within industry standard TIA/EIA 19" mounting rails unless otherwise noted.

2. All patch panels are to provide adequate space for individual port labeling on the front and cable/connector labeling on the back.

3. All installed UTP patch panels shall consist of twenty-four (24) or forty-eight (48) port patch panels with ports for each cable as indicated in the T-series drawings.

4. The performance criteria for the UTP patch panels must meet or exceed the performance parameters for frequency, attenuation, near end cross-talk (NEXT), attenuation to cross-talk ratio (ACR), power sum NEXT (PS-NEXT), power sum ACR (PS-ACR), equal level far end cross-talk (ELFEXT), power sum far end cross-talk (PS-FEXT), and return loss (RL) as set forth in ANSI/TIA-568 Category-6 standards.

C. Accessory Products:

1. Patch panel cable management bars shall be provided to support cable routing to each termination panel.

2. Provide any accessory products related to the UTP patch panels to provide a complete and functional infrastructure system.

3. Provide complete with all required mounting hardware, fittings and cables needed to form a bonded (grounded) system including manufacturer provided star washers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 UTP PATCH PANELS

A. Install all optical fiber UTP termination panels according to manufacturer's instructions and per all ANSI/TIA-568 standards as shown in the T-SERIES drawings.

B. The installation and performance parameters of all installed cable termination panels shall be verified by the contractor through ANSI/TIA-568 testing procedures.

C. Label all cable termination panels to identify each port and each specific panel in accordance with the ANSI/TIA-606 labeling scheme approved by Owners Representative.

D. Copper Category-6 UTP cables terminate on twenty-four (24) or forty-eight (48) port patch panels as indicated in the T-SERIES drawings.

E. The installation and performance parameters of all installed cable termination panels shall be verified by the contractor through ANSI/TIA-568 testing procedures.

F. Spare port

3.3 COPPER PATCH PANEL CABLE DRESSING

1. Cables shall be dressed to the termination point as follows:

a. Cables for ports on the right half of the patch panel shall be routed in the vertical cable manager on the right as you look at the back of the patch panel

b. Cables for ports on the left half of the patch panel shall be routed in the vertical cable manager on the left as you look at the back of the patch panel

3.4 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART 3.7

3.5 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART 3.8

END OF SECTION

SECTION 27 13 33

COMMUNICATION COAXIAL BACKBONE 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.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. RG-11 Coaxial Cabling

B. QR 540 Coaxial Cable

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for coaxial backbone cabling to distribute RF-based signals between telecommunications distribution spaces.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

1. No Substitution without pre-approval

2.2 RG-11 COAXIAL CABLE

A. Manufacturer List:

1. Belden

2. Commscope
3. Superior Essex

B. Description

1. RG-11 coaxial cable shall exhibit a nominal impedance of seventy-five (75) Ohms.
2. Typical attenuation for RG-11 coaxial cables shall be 3.5dB (± 0.5 db) per 100 feet (100') of cable at a seven hundred and fifty (750) megahertz wavelength. All coaxial cables shall be swept-tested to 2.2 GHz or greater.
3. The coaxial center conductor shall be solid gauge that is encased by a foam dielectric used to meet or exceed electrical and fire-safety and code compliance and performance.
4. RG-11 coaxial cable shall exhibit stable performance in a building environment, as well as in an exterior exposed environment, and shall have a minimum ninety five percent (95%) braided shield design.
5. RG-11 coaxial cables that are exposed to moisture shall contain moisture-blocking materials to prevent moisture damage to cable performance.
6. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.

C. Accessory Products:

1. Provide any accessory products related to the coaxial backbone cabling required to provide a complete and functional infrastructure system.

2.3 QR 540 COAXIAL CABLING

A. Manufacturer List:

1. Commscope Products

B. Product Options:

1. QR 540 JCAR – Indoor Riser (CATVR)
2. QR 540 JCASS - Underground

C. Description

1. QR 540 coaxial cable shall exhibit a nominal impedance of seventy-five (75) Ohms.
2. Typical attenuation for QR 540 coaxial cables shall be 1.80dB (± 0.5 db) per 100 feet (100') of cable at a seven hundred and fifty megahertz wavelength.
3. The coaxial center conductor shall be solid gauge that is encased by a dielectric used to meet or exceed electrical and fire-safety and code compliance and performance.
4. QR 540 coaxial cable shall exhibit stable performance in a building environment, as well as in an underground exposed environment. Coaxial cables that are exposed to moisture shall contain moisture-blocking materials to prevent moisture damage to cable performance.
5. Select an appropriate cable construction considering code requirements and environmental conditions when installing cables in aerial, outdoor, underground and corrosive environments.

D. Accessory Products:

1. Provide any accessory products related to the coaxial backbone cabling required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 BACKBONE COAXIAL CABILING

A. Install all backbone coaxial cable per BICSI Best Practices, the manufacturer’s installation instructions and ANSI/TIA-568 standards, and in quantities indicated in the T-series drawings.

B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly.

C. Backbone coaxial cable shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the owner.

D. Install backbone coaxial cables with attention paid to aesthetic means and methods when routing cabling within IT spaces. No backbone cable shall be left unsupported for more than five (5) feet vertically or horizontally at any time.

E. All backbone coaxial cables shall be clearly labeled on both ends and in an accessible location no more than one (1) foot from each cable end.

3.3 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART 3.7

3.4 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART 3.8

END OF SECTION

SECTION 27 13 34

COMMUNICATION COAXIAL SPLICING AND TERMINATION

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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. RG-11 Connectors

B. RG-6 Connectors

C. QR 540 Connectors

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for the termination of coaxial station and backbone cabling to distribute RF-based network signals between telecommunications distribution spaces and to/from coaxial workstation outlets.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

1. No Substitution without pre-approval

2.2 RG-11 F-TYPE CONNECTORS

A. Manufacturer List:

1. Belden
2. Thomas & Betts

B. Description:

1. RG-11 coaxial connectors shall be sealed to prevent moisture from migrating into the connector and have three hundred sixty (360) degree radial compression.
2. All coaxial connections shall have a minimum cable retention rating of forty (40) pounds.
3. All modular outlet coaxial connectors shall function to the specified performance parameters for video signal traffic that is connected via video patch cords in the IDF(s), Head End and/or MDF.
4. Ensure connector size and type is compatible with the specified RG-11 backbone cable.
5. Utilize corrosion resistant connectors when applicable.

C. Accessory Products:

1. Provide any accessory products related to the coaxial cabling termination connectors required to provide a complete and functional infrastructure system.

2.3 RG-6 F-TYPE CONNECTORS

A. Manufacturer List:

1. Belden
2. Thomas & Betts

B. Description

1. RG-6 coaxial connectors shall be sealed to prevent moisture from migrating into the connector and have three hundred sixty (360) degree radial compression.
2. All coaxial connections shall have a minimum cable retention rating of forty (40) pounds.
3. All coaxial connections shall be manufactured with RG-6 F-type interface that is compatible with components specifically manufactured for RG-6 F-type threaded ports.
4. All modular outlet coaxial connectors shall function to the specified performance parameters for video signal traffic that is connected via video patch cords in the IDF(s), Head End and/or MDF.
5. Ensure connector size and type is compatible with the specified RG-6 backbone cable.
6. Utilize corrosion resistant connectors when applicable.

C. Accessory Products:

1. Provide any accessory products related to the coaxial cabling termination connectors required to provide a complete and functional infrastructure system.

2.4 QR 540 CONNECTORS

A. Manufacturer List:

1. Corning Gilbert Products
2. Belden

3. Thomas & Betts

B. Product Options:

1. The indicated manufacturers shall be the basis of the design and each component selected shall address the particular infrastructure requirements.

C. Description

1. QR 540 coaxial connectors shall be 2-piece connector construction with a bandwidth range from 5 MHz to 1 GHz. Nominal impedance shall be 75 ohms.

2. The connector shall be constructed from ASTM 6000 series aluminum alloy with gold chromate conversion coating for corrosion resistance. Contact pins and support sleeves shall be brass with bright acid tin plating for RF conductivity.

3. All modular outlet coaxial connectors shall function to the specified performance parameters for video signal traffic that they support.

4. Ensure connector size and type is compatible with the specified QR 540 backbone coaxial cable.

5. Utilize corrosion resistant connectors when applicable.

D. Accessory Products:

1. Provide any accessory products related to the coaxial cabling termination connectors required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 RG-11, RG-6, QR 540 CONNECTORS

A. Install all connectors and required couplers per the manufacturer's installation instructions and ANSI/TIA-568 standards, and in quantities indicated in the T-series drawings.

B. The installation and performance parameters of all installed connectors shall be verified by the contractor through ANSI/TIA-568 testing procedures for each connector.

3.3 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. PART 3.7

3.4 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. PART 3.8

END OF SECTION

SECTION 27 15 13

COMMUNICATION COPPER HORIZONTAL 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.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Category 6 Four-Pair UTP Cabling

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for four-pair UTP copper horizontal workstation cabling to distribute network signals from telecommunications distribution spaces to workstation outlet locations.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

1. No Substitution without pre-approval

2.2 FOUR PAIR UTP CABLING

A. Manufacturer List:

1. Ortronics Category-6 UTP
2. Leviton Category-6 UTP
3. Belden Category-6 UTP

B. Description

1. All augmented Category-6 performance four (4) pair UTP cable shall consist of eight (8) twenty-three (23) gauge, or twenty-two (22) gauge, thermoplastic insulated solid twisted conductors that utilize the industry standard color code designations and provided with overall aluminum foil shield and longitudinal drain wire.

2. The performance criteria for four (4) pair UTP cable shall be meet or exceed specific ANSI/TIA-568 standards for Category-6 cable rating and shall show stable performance with documented electrical characterization out to 250 MHz.

3. Cables shall be rated per the installation environment as required by the local AHJ and building codes.

4. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.

C. Accessory Products:

1. Provide any accessory products related to the UTP copper 4-pair cabling required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

1. Electrical requirements (conduit installation and capacity)

2. The telecommunications rooms are the size shown on the project drawings.

3. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.

4. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 FOUR PAIR UTP CABLING INSTALLATION

A. Install all horizontal station cabling per the manufacturer's recommended installation instructions, under the guidelines of ANSI/TIA-568 and BICSI best practices, and in quantities indicated in the T-SERIES drawings.

B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded as noted in BICSI best practices. Also refer to the cable manufacturer's specifications for exact cable requirements per the particular cable type.

C. Cable Bundles

1. Bundling of cables is to be avoided; where bundling is necessary bundles shall be limited to no more than 24 cables.

2. Allow cables to lay naturally in cable tray and runways whenever possible.

3. Cables shall be neatly dressed from the point of emergence from vertical cable managers to the point of termination.

D. All cables shall be visually inspected for sufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to Owner.

E. Contractor shall ensure that all industry standards and best practices are met, with special regard to maximum pair un-twist. No twisted pair cables shall have more than three-eight inch (3/8") of pair un-twist. The cable jacket shall be maintained as close as possible to the connecting hardware.

F. Install the horizontal cabling with attention paid to aesthetic means and methods when routing cabling within IT spaces. All horizontal cabling should terminate in their respective floor serving technology space; specifically cables from floor outlets need to terminate in their corresponding floor telecom room.

G. All cabling distributed horizontally through metal stud framing shall have plastic protective bushings inserted to protect cables prior to installation.

H. All cables shall be clearly labeled on both ends and in an accessible location no more than six inches (0'-6") from the cable ends.

I. Owner reserves the right to specify a new location for any outlet or equipment without increasing contractor unit cost – providing that the new location is specified prior to roughing-in of technology cable and is not farther than ten (10) feet away from the original location specified.

3.3 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART3.7

3.4 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART3.8

END OF SECTION

SECTION 27 15 43

COMMUNICATION FACEPLATES AND CONNECTORS

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. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 DESCRIPTION

A. The work covered by this Specification Section includes all labor necessary to perform and complete such construction, materials not provided by the Owners Representative, equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1.3 SECTION INCLUDES

A. Copper UTP Connectors

B. Outlet Housing Components (faceplates etc.)

1.4 REFERENCE STANDARDS AND CODES

A. Refer to Section 27 00 00 Communications for list of Reference Standards, Codes, and Documents. PART 1.3

1. Specific standards may be referenced throughout this section.

1.5 SCOPE

A. Provides specifications for horizontal workstation cable termination components and outlet housing component. Includes wall-mount, floor-mount, and ceiling-mount components to support the various workstation outlets throughout the cabling plant.

1.6 SUBMITTALS

A. Refer to Section 27 00 00 Communications. - PART 1.10

1.7 QUALITY ASSURANCE

A. Refer to Section 27 00 00 Communications. - PART 1.11

1.8 CONTRACT ADMINISTRATION

A. Refer to Section 27 00 00 Communications. – PART 1.12 – 1.13

PART 2 - PRODUCTS

2.1 ALTERNATES AND SUBSTITUTIONS

A. Refer to Section 27 00 00 Communications. PART 1.7 – 1.8

1. No Substitution without pre-approval

2.2 COPPER UTP CONNECTORS

A. Manufacturer List:

1. Ortronics Category-6 UTP Connectors

2. Leviton Category-6 UTP Connectors
3. Belden Category-6 UTP Connectors

B. Description:

1. All UTP connectors shall be rated to perform at or above current ANSI/TIA-568 performance parameters of the UTP cabling it is terminating within the communications system.
2. All UTP connectors shall have an eight (8) Position, eight (8)-Contact (8P8C) module that accepts 8P8C plugs.
3. When utilized as part of a channel or permanent link, all high performance modular connectors shall match the horizontal cable performance transmission requirements before and after installation as specified in ANSI/TIA-568 Commercial Building Telecommunications Cabling Standard (horizontal cable section) in all noted performance parameters.

C. Accessory Products:

1. Provide any accessory products related to the UTP connectors required to provide a complete and functional infrastructure system.

2.3 OUTLET HOUSING COMPONENTS

A. Manufacturer List:

1. Ortronics
2. Leviton
3. Belden

B. Description:

1. All outlet housings at the various technology outlet locations shall provide the designated number modular insert ports as indicated in the T-series drawings.
2. All flush-mounted faceplates shall be provided per the port configuration as shown on the telecom drawings.
3. Faceplates for wall-mounted phones shall be one (1) port single gang faceplates that have wall-mount lugs allowing vertical phone mounting.
4. Faceplates for flush floor mounted outlets shall be coordinated with the floor box or poke thru device that will be selected and installed outside the scope of this section.
5. System furniture faceplates shall be capable of fitting in the furniture system selected by Owners Representative. Furniture faceplates shall be provided per the port configurations shown on the telecom drawings. Furniture faceplate extenders shall be used (if required) to maintain proper bend radii within the furniture raceway/pathway.
6. Surface mounted boxes shall be capable of the quantity of outlet jack requirements at each outlet locations indicted in the T-SERIES drawings.
7. All outlet-housings shall provide a clear ANSI/TIA-606 labeling location for both the individual outlet port and the entire outlet housing location, unless otherwise indicated in the project drawings.

C. Accessory Products:

1. Provide any accessory products related to the workstation outlet housing components required to provide a complete and functional infrastructure system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section.

3.2 COPPER UTP CONNECTORS

A. Process:

1. Install all connectors per ANSI/TIA-568 standards, BICSI Best Practices, and manufacturer instructions.

2. The installation and performance parameters of all installed couplers and connectors shall be verified by the trade contractor through ANSI/TIA-568 testing procedures.

3.3 OUTLET HOUSINGS

A. Process:

1. Color of all outlet housing components shall be coordinated with Owners Representative before purchase and installation.

2. All technology outlets located on walls shall be flush mounted, level and plumb.

3. All technology outlets shall be mounted at right angles and parallel to the floor, unless installation requirements or design dictate otherwise.

4. Install blank inserts in outlet housing spaces that are not being filled with cable termination modules. Blank inserts shall match the workstation housing color, unless otherwise indicated in the T-SERIES drawings.

5. All outlets located in systems furniture may be served from a wall adjacent to the furniture cluster or a floor box. If the cable is exposed prior to entering furniture raceway, install spiral wrap tubing to protect the cable per the manufacturer's recommendations.

6. All outlet housings as well as each individual utilized port shall be labeled in accordance with Owners Representative approved labeling scheme.

3.4 RE-INSTALLATION

A. Refer to Section 27 00 00 Communications. - PART 3.7

3.5 CLOSEOUT ACTIVITIES

A. Refer to Section 27 00 00 Communications. - PART 3.8

END OF SECTION

SECTION 28 31 00

FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Base Bid:

1. Electrical Contractor:

a. Contractor shall provide all materials and labor required for installation of related fire alarm system devices as shown and herein specified:

1) System smoke detectors
2) Heat detectors
3) Notification appliances
4) NAC power supply
5) Addressable interface device
6) Wire and Cable
7) Re-programming of existing fire alarm system control and annunciator panels.

1.2 RELATED WORK

A. Specified elsewhere:

1. Division 26 specification sections
2. Division 27 specification sections
3. Division 28 specification sections

1.3 SUMMARY

A. Section includes modifications to the existing fire alarm system in order to accommodate new fire alarm devices.

B. Supervisory sprinkler and smoke duct detector systems shall be of the addressable type and shall match existing fire alarm system device/equipment manufacturer.

C. Complete and operational fire alarm system will consist of the following:

1. Smoke detectors.
2. Heat detectors.
3. Addressable interface device.

1.4 DEFINITIONS

A. Definitions in NFPA 72 apply to fire-alarm terms used in this Section.

B. Addressable Analog System: Utilizing a signaling method characterized by the simultaneous or sequential transmission, or both, and the reception of multiple signals in a communication channel, including means for positively identifying each signal.

C. NAC: Notification appliances circuit.

D. IAC: Initiating appliances circuit.

E. SLC: Signaling line circuit.

F. NICET: National Institute for Certification in Engineering Technologies.

G. Pathway Class Designations.

1. Pathways shall be designated as Class A, Class B, Class C, Class D, Class E, or Class X, depending on their performance.

H. Signaling Line Circuit – Addressable Loop

1. Class A. A pathway shall be designated as Class A when it performs as follows:

a. It includes a redundant path.
b. Operational capability continues past a single open.
c. Conditions that affect the intended operation of the path are annunciated.
d. Isolator module located every 15 devices.

I. Notification Appliance Circuits, and Initiating Device Circuits

1. Class B. A pathway shall be designated as Class B when it performs as follows:

a. It does not include a redundant path.
b. Operational capability stops at a single open.
c. Conditions that affect the intended operation of the path are annunciated.

J. WLAN, LAN, Internet Wireless or POTS

1. Class C. A pathway shall be designated as Class C when it performs as follows:

a. It includes one or more pathways where operational capability is verified via end-to-end communication, but the integrity of individual paths is not monitored.
b. A loss of end-to-end communication is annunciated.

K. Unsupervised Circuits

1. Class E. A pathway shall be designated as Class E when it is not monitored for integrity.

1.5 SUBMITTALS

A. General Submittal Requirements:

1. All submittals shall be approved by the AHJ prior to the beginning of any work.
2. Shop Drawings shall be prepared by persons 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. Submission to the AHJ:

1. Submit detailed drawings in accordance with the BFP's procedures and requirements for the fire alarm plan review.
2. Provide identical submittal to the Architect for concurrent review.
3. Upon receipt of the comments from BFP, submit a copy of all the annotated drawings or correction sheets to the Architect.
4. Incorporate all comments into the detailed drawings and resubmit to the BFP until approval is obtained.

C. Product Data: For each type of product indicated. Provide manufacturers product data sheets, showing the types and models and manufacturer's installation/instruction of all equipment, devices and wire/cable proposed. Evidence of FM & ULI Listings and local approvals shall be submitted with the data sheets. Catalog numbers alone are not acceptable. Each document shall be highlighted indicating the model proposed, specific data, and cross out items that are not applicable for the work.

D. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with the requirements of the local authority having jurisdiction (AHJ) and recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits. Provide circuit calculations that include all system requirements including any requirements for notification appliance circuits, or any other auxiliary function powered by the system. All notification appliance circuit(s) shall be sized with 10% voltage drop at 24 volts.
3. Include battery-size calculations. Battery calculations shall list the type of devices and modules, quantities, unit and extended amperage draw for quiescent and alarm conditions, total amperage draw and battery amp/hour rating. For design criteria, the battery amp/hour rating listed by the manufacturer shall be de-rated by 20%. Include all system requirements including any requirements for visual signaling appliances, or any other auxiliary function powered by the system.
4. Include system operation description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
5. Include system riser diagram with device addresses, conduit sizes, cable and wire type and sizes.
6. Include wiring diagrams: power, signal and control wiring. Include diagrams for equipment and for system with all terminals and connections identified. Show wiring color code.
7. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
8. Include device address list: Coordinate with final system programming.
9. Point List: Provide complete zone list each initiating zone (device address), annunciator zone, custom message descriptor, notification appliance circuits, auxiliary function

circuit, and the specific device associated with each function or zone. Descriptors shall be based on Room Signage Numbers.

10. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
11. Submit electronic copy of drawings, on CD or DVD, to Architect.

E. Qualification Data: For Installer.

F. Field Test Reports: Submit test reports documenting the activities and procedures specified. Submit reports within two weeks of completion of start-up procedures.

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 Division 01 Section "Operation and Maintenance Data," deliver copies to the Board Authorized Representative, Architect and to the AHJ. Provide six (6) copies of materials, both hardcopy and electronic, in format required by Board Authorized Representative. Include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72 and AHJ.
2. Provide "Record of Completion Documents" according to AHJ and NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Provide "Maintenance, Inspection and Testing Records" according to AHJ and NFPA 72 article of the same name and include the following:
4. Frequency of testing of installed components.
5. Frequency of inspection of installed components.
6. Requirements and recommendations related to results of maintenance.
7. Manufacturer's user training manuals.
8. Manufacturer's required maintenance related to system warranty requirements.
9. Provide spare parts data. Provide the name, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.
10. Abbreviated operating instructions for mounting at fire-alarm control unit.

H. Training Reports: Submit reports on training documenting topic covered, dates and attendance.

I. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: Complete with data files, in format required by Board Authorized Representative.
3. Device address list.
4. Printout of software program.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
2. As a precondition to the contract, the Installer shall be regularly engaged in the design, servicing, installation and testing of fire detection and alarm notification systems, shall

have at least five years of experience in the installation of fire detection and alarm notification systems.

3. Shop Drawings shall be prepared by persons with the following qualifications:
4. Trained and certified by manufacturer in fire-alarm system design.
5. NICET-certified fire-alarm technician, Level III minimum.

B. Source Limitations for Fire-Alarm System and Components: New fire alarm components shall be compatible with, and operate as an extension of, the existing system.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the National Electrical Code, and marked for intended location and application.

D. Comply with International Building Code.

E. Comply with NFPA 72, current Edition.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire alarm system components and devices in original factory shipping cartons, with original labels intact.

B. Handle fire alarm system components and devices in accordance with manufacturer's written instructions, to avoid damage.

C. Store fire alarm system components and devices indoors in clean, dry space with uniform temperature to prevent condensation. Protect fire alarm system components and devices from exposure to dirt, fumes, water, corrosive substances, and physical damage.

D. Install temporary plastic covers on smoke detectors. Remove covers immediately before final system testing.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by the using agency unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Architect and Board’s Authorized Representative no fewer than ten working days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Architect's and Board Authorized Representative's written permission.
3. Guard service shall be provided for 24 hours each day for the duration of the fire alarm system interruption. Fire watch personnel shall make rounds on hourly intervals.

1.9 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment and devices have 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.

1.10 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. Smoke Detectors, Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
2. Detector Bases: Quantity equal to 5 percent of amount of each type installed, but no fewer than 1 unit of each type.
3. Keys and Tools: Two extra sets for access to locked and tamper-proof components.
4. Audible and Visual Notification Appliances: Quantity equal to 5 percent of each type installed, but no fewer than 1 unit of each type.

1.11 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 Division 01 Sections “Closeout Procedures” and “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 Using agency notifying the contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Electrical contractor shall field verify existing Fire Alarm manufacturer and match devices prior to rough-in. All new devices shall be fully compatible with existing Fire Alarm system.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Class I system fire-alarm signal initiation shall be by one or more of the following devices:

1. Heat detectors.
2. Smoke detectors.

B. Fire-alarm signal shall initiate in the general alarm condition the following actions or sequence of operations where applicable:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and local remote annunciator.
3. Transmit an alarm signal to the Fire Department via City Tie Connection.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Transmit signal to the Building Automation System to switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Activate emergency lighting control.

8. Record events in the system memory.

C. Program existing fire alarm control panel for Elevator Recall:

1. Intelligent Addressable 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 detectors in elevator machine room, control space and control room.

2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.
3. Floor main waterflow switch operation on the designated floors shall cause the cars to move to the alternate recall floor.
4. Emergency recall operation shall notify the Fire Department via City Tie Connection and annunciated at the same location as FAA and SSA.
5. Elevator recall system shall comply with the International Building Code.

D. 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 and supervisory signals shall be powered by 24-V dc source. The fire alarm control panel shall be fed from a 20 amp, 120VAC, single-phase branch circuit breaker. This circuit breaker must be permanently identified in "RED" and shall be provided with a permanent identification label that reads "FIRE ALARM CIRCUIT".

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

E. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

F. Automatic transfer switch: Transfer the load to the battery without loss of signals or status indications in the event of failure of primary power.

G. Batteries: System control equipment shall receive secondary operating power from batteries integral to the equipment. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply. 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.

H. 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.

I. Surge Protection:

1. Install surge protectors recommended by control panel manufacturer. Install on all system wiring external to the building housing the control panel.

J. 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.

K. Systems: Alarm and supervisory systems in FCP/SSCP shall be completely separate and independent. The alarm initiating zone boards in the FCP/SSCP shall consist of plug-in cards. Construction requiring removal of field wiring for module removal is not acceptable.

L. 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.

M. Indicating Lights: Provide individual alarm and trouble LED for each zone. Provide a System LED test switch for each FCP/SSCP section that will illuminate all LED devices on that section of the control panel. Alarm and supervisory signals shall light a red LED of the associated zone. Trouble signals shall light an amber LED for the associated zone.

N. Smoke/Fire Zones

1. Each floor shall be group zoned by building according to the fire partition construction with further breakdown as to the device type.
2. Additional zones shall be dedicated to:

   a. Food Service Fire Extinguishing System.
   b. Elevator Capture Control.
   c. Each electrical equipment room.
   d. Each mechanical/pump room.
   e. Each telephone/data room.

2.3 SYSTEM SMOKE DETECTORS

A. Requirements for Analog Addressable System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Intelligent Addressable Analog Type: Designed to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Multipurpose type, containing the following:

   a. Integrated Addressable Module: Arranged to communicate detector status (normal, alarm, dirty, trouble or maintenance) to the FCP.
   b. 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.
   c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   d. Integral Visual-Indicating Light: Blinking LED type indicating detector is communicating properly and turn RED in alarm.

4. 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.
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 average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

2.4 HEAT DETECTORS

A. General Requirements for Analog Addressable 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 per minute. Fixed temperature sensing shall be independent from rate-of rise sensing.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integrated Addressable Heat Detector: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Provide devices in ordinary ambient temperature rooms.

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. Integrated Addressable Heat Detector: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. Provide devices in high ambient temperature rooms.

2.5 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single- mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Trouble Bells: Electric-vibrating, 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. 4-inch size, unless otherwise indicated. Bells are weatherproof where indicated.

C. Audible Alarm-Indicating Devices (Horns): Comply with UL 464; factory finish: red. Devices shall be constructed for safe use in boiler rooms, kitchens and exterior locations without impairing the quality of tone reproduction in ambient conditions ranging from 30 degrees Fahrenheit to 150 degrees Fahrenheit. Horns shall be sound level setting of 92dB at 10 feet

using the coded signal prescribed in UL 464 Test Protocol. Horn shall mount to surface or flush box. When flush mounted, the Horn shall extend less than one inch from the wall.

1. Horns shall be field configurable for continuous, temporal, or march time pattern.
2. In temporal or march time mode horn operation shall be synchronized.

D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens. 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. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be synchronized with other units in common viewing areas per ADA and NFPA 72. Provide properly sized outlet box to accommodate synchronizing device on strobe circuit.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

2.6 NAC POWER SUPPLY:

A. The NAC power supply shall be independent unit that will provide power to visual strobe notification appliances. It shall be possible to configure NAC power supply activated from intelligent synchronized modules. The power supply NAC's must be configurable to operate independently at any one of the following rates: continuous synchronized, or 3-3-3 temporal. Fault conditions on the power supply shall not impede alarm activation of host NAC circuits or other power supplies. The NAC power supply must be able to provide concurrent power for notification devices, security devices, access control equipment and auxiliary devices such as door holders. All the NAC Power Supplies shall be synchronized. The power supply shall support up to 24 Amp hour batteries.

1. Power supply shall be minimum of 8 amps and UL 864 Listed.
2. Four independent 2 Amp NAC circuits. Each being configurable as auxiliary power.
3. All circuits shall be synchronized.

2.7 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 or to interface with BAS system.

C. Three supervised relays shall be provided for each elevator controller to activate for primary recall, alternate recall and fire hat indicator in the car.

2.8 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with IBC, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, or solid copper conductor, not less than No. 14 AWG, or 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.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with International Building Code and NFPA 72 for installation of fire-alarm equipment.

3.2 CONNECTIONS

A. 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 elevator recall system and components.
2. Alarm-initiating connection to activate emergency lighting control.
3. Supervisory connections at valve supervisory switches.
4. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
5. Supervisory connection with Elevator power Shutdown.
6. Supervisory connection with Kitchen Fire-extinguishing system operation.

a. Supervisory connection with Duct Detectors.
b. Supervisory connection with Door Systems.
c. BAS system interconnections.

3.3 WIRING INSTALLATION

A. Install wiring according to the following:

1. NEC 70-2014, National Electrical Code.
2. NFPA 72-2013, National Fire Alarm Code.
3. NECA 1.
4. 101-12, Life Safety Code.
5. Refer to Division 1, Regulatory Requirements, specification 01 41 00 for all defined code editions.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."

1. Fire alarm circuits and equipment control wiring associated with the 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 within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red. Identify the accessible raceway with color-coded, self-adhesive red vinyl tape applied in bands.

F. SLC Risers: Install at least two vertical cable risers to serve the fire alarm system or as required by Fire Prevention Bureau. Separate risers in close proximity to each other with a minimum 2-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

G. Circuits for electromagnetic door hold-open devices shall be run in conduits separate from those containing system initiating or indicating device circuits.

H. Install separate and completely independent conduits for fire alarm and sprinkler supervisory systems.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes to match original factory finishes.

C. Prior to the acceptance testing, remove plastic covers from smoke detectors.

3.6 CONTRACTOR START UP AND REPORTING

A. Field tests shall be witnessed by the using agency's Representative, AHJ.

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. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72 and as required by the AHJ.
2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72 and as required by the AHJ.
3. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
4. Include the existing system in tests and inspections.
5. Visual Inspection: Conduct visual inspection prior to testing.
6. 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 and as required by the AHJ.

    a. 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.

7. Pretesting:

    a. Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting.
    b. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications.
    c. Prepare forms for systematic recording of pretest results.
    d. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable. The letter shall include the names and titles of the witnesses to the preliminary tests.

8. Final Test Notice: Provide 10 days minimum notice in writing when the system is ready for final acceptance testing.
9. Minimum System Tests: Test the system in accordance with the procedures outlined in NFPA 72 Chapter 10 and as required by the AHJ.
10. Minimum required tests are but not limited to the ones listed below:

    a. Correct deficiencies observed in pretesting.
    b. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
    c. Verify the absence of unwanted voltages between circuit conductors and ground.

d. Test all conductors for short circuits utilizing an insulation testing device.
e. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
f. Verify the control units are in the normal condition as detailed in the manufacturer's operating and maintenance manual.
g. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Proper signal transmission in accordance with class of wiring used shall be observed.
h. Test each initiating and indicating device for alarm operating and proper response at the control unit. Test smoke detectors with actual products of combustion.
i. Test the system for all specified functions in accordance with the manufacturer's operating and maintenance manual. Systematically initiate specified functional performance items at each station including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe displays, signal tones, and annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
j. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.

11. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" as required in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" as required in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
12. Provide all documentation as required by the AHJ.
13. Reacceptance Testing:

a. Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
b. Tag all equipment and stations and other components at which tests have been satisfactorily completed. Place tags upon completion of tests.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 COMMISSIONING AND DEMONSTRATION

A. Provide the services of a factory-authorized service representative to demonstrate and train The Board's maintenance personnel as specified below.

1. Train the Board's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Include AHJ. Provide a minimum of 8 hours' training.
2. Schedule training with the Board at least seven days in advance.

3. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

B. Train using agency's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining the equipment. The training shall occur after the startup report has been provided to the using agency and the trainer will provide

two (2) Installation and Operations manuals for the use of the using agency's personnel during training. Provide a minimum of two (2) sessions of four (4) hours of training. Provide no more than one training session per day.

1. Training Agenda:

    a. Format shall be an outline broken up into (2) 4-hour sessions.
    b. The material to be covered shall be sub divided into the description of the material to be covered for each 15 minutes intervals.
    c. The descriptions shall include not only the material to be covered but also its location in the Installation and Operations manuals, including Section and page number.

2. Documentation of training: After each 4-hour session the engineer shall initial and date the items on the training agenda that were covered that day.

A. 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 trouble shooting. If the IOM does not include a written trouble shooting guide one will be provided.

B. Demonstrate proper operation of equipment to commissioning agent or designated using agency's 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 01 or 15.

END OF SECTION

SECTION 31 11 00

SITE CLEARING

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. 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 23 “Acceptance of Backfill, Top Soil, & CU Structural Soil”.

1.3 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 nonsoil 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 according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

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

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project Site.

1. Review rock / topsoil stripping and stockpiling programs.

1.5 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.

1.6 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.

1.7 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 Sotckpiling 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 with in program description.

1.8 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

2.1 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, Top Soil, & CU Structural Soil."

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 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."

3.4 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."

3.5 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, Top Soil, & 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.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Topsoil is defined as friable clay loam surface soil. Strip topsoil to depth indicated on drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil 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 so as 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.

3.7 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

3.8 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 11 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 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, top soil 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, Top Soil, & 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 top soil 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.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. All imported soil material must comply with Section 31 23 23 "Acceptance of Backfill, Top Soil, & 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.

D. Select Fill: Clean natural or crushed stone or gravel conforming to State of Illinois, Department of Transportation Gradation CA 6.

E. Use Contractor supplied off-site material except that general fill may be from excavation if found acceptable by the testing agency.

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 bench mark and intended elevations for the Work are as indicated.

B. Verify the absence of standing or ponding water.

C. Verify subdrainage, dampproofing, 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 through the use of 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 11 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" 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” 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. Proofrolling Observation:

1. Provide continuous observation of proofrolling 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 11 00 “Site Clearing”.
2. Section 31 22 14 “Earthwork”.
3. Section 31 23 18.13 “Subtitle D Waste Disposal”.
4. 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, Top Soil, & 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, Top Soil, & 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 on a daily basis 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 located 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 course of 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 so as 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 on a daily basis. 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 sufficient amount of 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 period 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 come into contact with 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 the 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 in order 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 on a monthly basis 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 the course of 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 are in compliance with 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 representative.
   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, so as 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

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, in compliance with all contract documents, specifications, and applicable laws and regulations.

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.

C. In order 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

A. 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.

B. 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 period 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 come in contact with 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 on a daily basis. 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

A. The Contractor shall manage the Work so as not to accumulate storm water on the site during excavation.

B. 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.

C. 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 the course of 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 are in compliance with 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, TOPSOIL & 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 32 13 13

CONCRETE PAVING

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 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, Top Soil, & CU Structural Soil”.
3. Section 32 17 23.13 “Painted Pavement Markings”.

1.3 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.

1.4 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, Top Soil, & CU Structural Soil."

1.5 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. Allow free access to material stockpiles and facilities at all times. 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.

1.6 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 2 - PRODUCTS

2.1 FORM MATERIALS

A. Comply with IDOT Specifications, Article 1103.05.

2.2 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.

2.3 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 in excess of 0.1 percent by weight of cement.

2.4 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.

2.5 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.

C. Concrete Properties:

1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 3500 psi.

2.6 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.

2.7 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 3 - EXECUTION

3.1 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.

3.2 SUBBASE

A. Comply with IDOT Specifications, Article 420.04.

B. Proofroll 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.

3.3 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Notify Architect minimum 24 hours prior to commencement of concreting operations.

3.4 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.

3.5 REINFORCEMENT

A. Place reinforcement at midheight 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.

3.6 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.

3.7 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.

3.8 CURING

A. Curing and protection shall be as outlined in IDOT Specifications, Articles 1020.13 and 1022. Color lithochrome 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.

3.9 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.

3.10 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.

3.11 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.

3.12 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

END OF SECTION

SECTION 32 90 00

LANDSCAPE PLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Plantings, planting installation materials and methods as shown in the drawings or inferable there from and as specified.

B. Related Documents:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

1.2 QUALIFICATIONS

A. Landscape planting and related work shall be performed by a firm with a minimum of five (5) years experience specializing in this type and size of work.

1.3 REQUIREMENTS OF REGULATORY AGENCIES

A. The Contractor shall provide for the protection of the public, employees and property, in accordance with the applicable requirements of Part 1926, Subpart P, "Excavation, Trenching and Shoring," CONSTRUCTION SAFETY AND HEALTH REGULATIONS (OSHA), which, by reference, is made a part of this specification including sections relative to protection of the public, trenches and excavating equipment.

B. Comply with all Federal or State regulations concerning classification or transportation of plants and fertilizer materials.

C. All planting procedures will conform to the accepted horticultural practices as established by the American Association of Nurserymen.

D. All landscaping shall conform to the City of Chicago Landscape Ordinance.

1.4 INSPECTION AND ACCEPTANCE

A. Preliminary Inspection: Plants shall be subject to inspection by the Landscape Architect at their place of growth and upon delivery for conformity to specification requirements. Such inspection shall not impair the right of rejection during progress of the work. Landscape Architect will perform 2 trips for tagging, additional trips will be paid for by the contractor:
1. A written request for inspection of plant material at their place of growth shall be submitted to the Landscape Architect at least ten calendar days prior to digging. This written request shall state the place of growth and quantity of plants to be inspected. The Landscape Architect reserves the right to refuse inspection at this time if, in his judgment, a sufficient quantity of plants are not available for inspection.
2. Plant material shall be tagged at their place of growth. For distant material, submit photographs for pre-inspection review.

B. Acceptance: The Landscape Architect will review all work for substantial completion upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of review. Acceptance of plant material by the Landscape Architect shall be for general conformance to specified size, character and quality, and shall not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.

C. Final Inspection: At the end of the guarantee period, the Landscape Architect will review all guaranteed work, upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date for final review.

1.5 SUBMITTALS - Landscape Planting

A. Certificate of Inspection: Shall accompany the invoice for each shipment of plants as may be required by law for transportation. File certificates with the Landscape Architect prior to acceptance of the material. Inspection by Federal or State authorities at place of growth does not preclude rejection of the plants at the site.

B. Guarantee: Submit a written guarantee for all plant material, subject to the limitations hereinafter set forth. All plant material shall be guaranteed by the Contractor for a period of one year from the date of acceptance to be in good, healthy and flourishing condition:
   1. When the work is accepted in part, the guarantee periods extend from each of the partial acceptances to the terminal date one year later.
   2. The Contractor shall replace, without cost to the Owner, and as soon as weather conditions permit and within a specified planting period, all dead plants and all plants not in a vigorous, thriving, condition as determined by the Landscape Architect during and at the end of the guarantee period. The plants shall be free of dead or dying branches and branch tips, and shall bear foliage of a normal density, size and color. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification
   3. The Contractor shall make all necessary repairs due to plant replacements. Such repair shall be done at no extra cost to the Owner.
   4. The Contractor shall make as many periodic inspections as necessary, at no extra cost to the Owner during the guarantee period to determine what changes, if any, should be made to the Owner's maintenance program. Submit, in writing to the Owner, any recommended changes.
   5. Submit one gallon sample of shredded hardwood bark mulch.
   6. Submit one gallon sample of planting soil backfill mix.
   7. Submit one gallon sample of very coarse sand used in planting soil mix.
   8. Submit one gallon sample of pine bark fines used in planting soil mix.
   9. Submit soil report of imported topsoil that includes soil classification, ph level, and percent of organic content.

PART 2 - MATERIALS

2.1 PLANTS

A. General: Refer to PLANT LIST on the drawings for specific types and quantities of plants to be

furnished. Contractor shall verify all quantities on the drawings and notify the Landscape Architect if any discrepancies are found. The number of plant symbols shown on the drawings supersedes any quantities given or provided in the Plant List.

1. Plants shall be nursery grown in accordance with good horticultural practices, as established by the American Association of Nurserymen, and grown under climatic conditions and in soil types similar to those in the locality of the project for at least two (2) years. All plants must come from nursery sources located in USDA Hardiness Zones 3, 4 or 5. They shall have been root pruned within the last two (2) years. The Landscape Architect must approve any exceptions.
2. Plants shall be freshly dug. No heeled-in-plants or plants from cold storage will be accepted, unless approved by the Landscape Architect.
3. Unless specifically noted otherwise, all plants shall be of specimen quality, exceptionally heavy, symmetrical and tightly knit, so trained or favored in their development and appearance as to be unquestionably and outstandingly superior in form, number of branches, compactness and symmetry.
4. They shall be sound, healthy and vigorous, well branched and densely foliated when in leaf. They shall be free of disease, insect pests, eggs or larvae, and shall have healthy, well developed root systems. They shall be free from physical damage or adverse conditions that would prevent thriving with the specified result.
5. Plants shall be of true species and variety, and shall conform to measurements specified in the plant lists, except that plants larger than specified may be used if acceptable to the Landscape Architect. Use of such plants shall not increase the contract price. If larger plants are accepted, the ball-of-earth shall be increased in proportion to the size of the plant.

B. Caliper Measurement shall be taken at a point on the trunk 6 inches above natural ground level for trees up to and including 4 inches in diameter, and at a point 12 inches above the natural ground level for trees over 4 inches in diameter.

C. Plant Size:
1. Plants shall be measured when branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch tip to tip.
2. If a range of size is given, no plant shall be less than the minimum size and not less than 50 percent of the plants shall be as large as the maximum size specified. The measurements specified are the minimum size acceptable and are the measurements after pruning, when pruning is required.
3. Plants that meet the measurements specified, but do not possess a normal balance between height and spread, shall be rejected.

D. Pruning: Trees shall not be pruned before delivery. Trees which have a damaged or crooked leader, or multiple leaders, unless specifically specified, will be rejected. Trees with abrasion of the bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 1-1/4” which have not completely calloused, will be rejected.

E. Plant Labels: Plant material labels shall be durable, legible labels stating the correct plant name and size in weather-resistant ink or embossed process. Attach securely to all plants, bundles, and containers of plant material delivered, being careful that those attached directly to plants will not restrict growth.

2.2 SOIL AND FERTILIZER

A. Salvaged topsoil from on-site clearing or excavation shall not be used as backfill for landscape planting.

B. Imported topsoil shall be fertile, friable loam topsoil, composed of 20-50%silt, 30-60% sand and 5-20% clay. It shall have a pH level of between 6 to 7 without mixture of subsoil and shall be free of stones, lumps, plants or their roots, sticks and extraneous matter, and shall not be delivered while in a frozen or muddy condition. It shall have an organic matter between 3-8%.
   1. Before delivery of topsoil is made, a certified analysis of the topsoil, made at the Contractor's expense by a recognized soil test laboratory, shall be submitted to the Landscape Architect. All soil delivered may be subject to further analysis and failure of the topsoil to average up to the submitted analysis will be grounds for rejection.

C. Commercial Fertilizer shall consist of commercial mixture, delivered to the site in the original unopened containers which shall bear the manufacturer's guaranteed statement of analysis, and shall be in a dry, free-flowing condition. Types of fertilizers shall depend upon soil analysis and species of plants.

2.3 MATERIALS FOR PLANTING

A. Planting Soil Mixture for back fill of plant pits or beds shall be as follows:

1.	Deciduous Tree, Shrubs	- 70% topsoil
		- 15% coarse sand
		- 15% pine fines
2.	Perennials and Groundcovers	- 50% topsoil
		- 25% coarse sand
		- 25% pine fines

B. Mulch material shall be finely shredded hardwood bark mulch free from twigs, leaves, or other debris. Mulch is not to contain any lumber or pallets and not be artificially colored.

PART 3 - EXECUTION

3.1 PREPARATION OF PLANT MATERIALS

A. Immediately before digging and following consultation with the Landscape Architect, spray all evergreen and deciduous plant material in full leaf with anti-desiccant, applying an adequate film over trunks, branches, twigs, and/or foliage.

B. Dig ball-and-burlap (B&B) plants with firm, natural balls of earth, of diameter not less than that recommended by American Standard for Nursery Stock, and of sufficient depth to include the fibrous and feeding roots. Plants moved with a ball will not be accepted if the ball is cracked or broken before or during planting operation.

3.2 EXCAVATION OF PLANTED AREAS

A. Stake out on the ground locations for plants and outlines of areas to be planted. The Landscape Architect will review the layout of planting areas on notification by the Contractor prior to the commencement of planting.

B. Shrub pits may be individually dug and backfilled.

C. Amend groundcover and perennial beds by incorporating a 3" layer of mushroom compost with the existing topsoil.

D. Separate subgrade soils from the upper "topsoil" portions and remove immediately, wherever encountered, during planting operations. Loosen subgrade in pits and beds to a depth of 6 inches.

E. Test each tree pit for drainage prior to installing trees or large shrubs. Use the following procedure:
   1. Dig each pit to the minimum specified size. Provide 12" of backfill in all directions around tree root balls.
   2. Fill planting pit with 12" of water. If water level drops 4" or more within 4 hours, the drainage is sufficient and a drainage channel is not required. If, however, the water level drops less than 4" in 4 hours, additional drainage is required. The Landscape Architect shall be notified immediately of any drainage problems.
   3. If the Landscape Architect determines that a subsoil drainage system is required, the Contractor shall prepare & submit drainage layout plans for approval prior to installment.
   4. All material excavated for the drainage system components shall be removed from the site and discarded.

F. If rock, underground construction work, tree roots or obstructions are encountered in the excavation of plant pits, it shall be brought to the attention of the Landscape Architect.

G. Excess or unsuitable subgrade soils shall be staged and removed from the site as demolition debris immediately following excavation of planted areas. Excavated soils originating below the cover fill layer shall not be used as backfill for plant pits or beds.

3.3 PLANTING

A. Planting Season: Planting shall be done only within the following dates. If special conditions exist which may warrant a variance in the planting dates, a written request shall be submitted to the Landscape Architect, stating the special conditions and the proposed variance. Permission for the variance will be given if, in the opinion of the Landscape Architect, the variance is warranted.
   1. Deciduous Trees: April 1 - Dec 1
   2. Evergreen Trees: April 1 - Dec 1
   3. Deciduous Shrubs: April 15 – Nov 15
   4. Evergreen Shrubs: April 15 – Nov 1
   5. Perennials, Groundcover, Ornamental Grasses May 1 – Oct 15

B. Planting Operations:
   1. Set plants at same relationship to finished grade as they bore to the ground from which they were dug. Use planting soil to backfill pit approximately 2/3 full. Water thoroughly before installing remainder of the planting soil to top of pit, eliminating all air pockets. Do not backfill beds with planting soil until they have been inspected by the Landscape Architect.
   2. Set planting plumb and brace rigidly in position until the planting soil has been tamped solidly around the ball and roots.
   3. Cut nylon ropes or strings from top of ball after plant has been set. Remove all ropes, wire and burlap from the top half of all root balls.
   4. Protect plants at all times from sun or drying winds. Plants that cannot be planted immediately on delivery shall be kept in the shade, well protected with soil, wet moss or other acceptable material, and shall be kept well watered. Plants shall not remain unplanted for longer than three (3) days after delivery.
   5. Plants shall not be bound with wire or rope at any time so as to damage the bark or break branches. Plants shall be lifted and handled from the bottom of the ball only.
   6. Mulch all tree pits, shrub beds and perennial or groundcover beds with shredded hardwood bark immediately after planting. Water all plants immediately after planting.
   7. Smooth planting areas to conform to specified grades after full settlement has occurred and mulch

has been applied.

C. Pruning:
   1. Prune plants only at time of planting and according to standard horticultural practice to preserve the natural character of the plant.
   2. Remove all dead wood, suckers and broken or badly bruised branches.
   3. Use only clean, sharp tools.

3.4 MAINTENANCE OF TREES, SHRUBS AND GROUNDCOVERS

A. Maintenance shall begin immediately after plant is planted and shall continue until acceptance with the following requirements:
   1. Maintenance of new planting shall consist of pruning, watering, cultivating, weeding, mulching, resetting plants to proper grades or upright position, and furnishing & applying such sprays as are necessary to keep the plantings free of insects and diseases.
   2. Planting areas and plants shall be protected at all times against trespassing and damage of all kinds for the duration of the maintenance period. If any plants become damaged or injured, they shall be treated or replaced as directed by the Landscape Architect at no additional cost to the Owner.

3.5 REMOVAL OF DEBRIS AND SURPLUS MATERIALS

A. During the progress of the work, the Contractor shall at all times keep the premises broom clean, free from accumulation of debris and surplus materials and shall regularly remove such materials from the job site. He shall at all times keep the driveways, parking areas and surrounding walkway surfaces free from debris including soil. Upon completion of his work or portions thereof, he shall remove all equipment, surplus materials and debris, leaving the site broom clean to the satisfactions of the Owner.

3.6 PROTECTION OF ADJACENT WORK

A. The Contractor shall protect all adjacent stone surfaces, electrical work and surrounding facilities from damage. He shall be held responsible to repair, to the satisfaction of the Landscape Architect, any stone surfaces or facilities damaged by him, his workmen or equipment during his operations.

3.7 CLEANING

A. All rubbish and debris resulting from the work of this Section shall be collected and removed from the site and disposed of legally.

B. All work shall be left in a broom clean condition.

END OF SECTION

SECTION 32 91 13

SOIL PREPARATION

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 planting soils specified by composition of the mixes.

B. Related Requirements:
1. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
2. Section 329300 "Plants" for placing planting soil for plantings.
3. Section 329600 "Transplanting" for placing planting soil in tree planting pits.
4. Section 329700 "Vegetated Roof Assemblies" for growing media (soil).

1.3 ALLOWANCES

A. Preconstruction and field quality-control testing are part of testing and inspecting allowance.

1.4 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include recommendations for application and use.
2. Include test data substantiating that products comply with requirements.
3. Include sieve analyses for aggregate materials.
4. Material Certificates: For each type of soil amendment and fertilizer before delivery to the site, according to the following:

    a. Manufacturer's qualified testing agency's certified analysis of standard products.
    b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.

c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Samples: For each bulk-supplied material, 1-quart (1-L) volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For each testing agency.

B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

C. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil.

1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.10 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by state-certified, soil scientist under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.11 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

    a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
    b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1- Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol, including the following:

1. Percentage of organic matter.

2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm [and sodium absorption ratio].
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance 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 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. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED BY COMPOSITION

A. Planting-Soil for Trees: Manufactured soil consisting of manufacturer's basic sandy loam according to USDA textures, blended in a manufacturing facility with coarse sand, and stabilized organic soil amendments (pine fines).

1. Additional Properties of Manufacturer's Basic Soil before Amending: Soil reaction of pH 6 to 7 and minimum of 6 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.
2. Unacceptable Properties: Manufactured soil shall not contain the following:

a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-1/2 inches (38 mm) in any dimension.

PART 3 - EXECUTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. 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 planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches (150 mm) and stockpile until amended.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 2-inch (50-mm) sieve to remove large materials.

3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 2 inches (50 mm) of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 6 inches (150 mm), but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments**.** and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
   a. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm)] in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 12 inches (300 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth of 12 inches (300 mm), but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply planting soil in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each lift of planting soil to **75** percent of maximum Standard Proctor density according to ASTM D 698.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.5 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 12 inches (300 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Apply soil amendments**, except compost,** and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
1. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to **75** percent of maximum Standard Proctor density according to ASTM D 698.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply 3 inches (75 mm) of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 PROTECTION

A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Vehicle traffic.
4. Foot traffic.
5. Erection of sheds or structures.
6. Impoundment of water.

7. Excavation or other digging unless otherwise indicated.

B. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.8 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

END OF SECTION 32 91 13

SECTION 329200

LAWNS 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. Sodding.
3. Lawn renovation.
4. Erosion-control material(s).

B. Related Sections:

1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
3. Division 32 Section "Exterior Plants" for ground covers and plants.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. CBR: California Bearing Ratio.

C. Finish Grade: Elevation of finished surface of planting soil.

D. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

E. Planting Soil Mix: Native or imported topsoil, manufactured topsoil, or surface soil modified to become Planting Soil Mix; mixed with soil amendments.

F. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

G. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

H. USDA: United States Department of Agriculture.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, origin, germination, inert matter, other crop seed, weed seed, and noxious weed seed. Include the year of production, date of packaging, lot number, and date of analysis.

1. Certification of each seed mixture for turfgrass sod, identifying source, including name and telephone number of supplier.

C. Qualification Data: For qualified landscape Installer.

D. Product Certificates: For soil amendments and fertilizers, from manufacturer.

E. Material Test Reports: For existing surface soil and imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

G. Maintenance Instructions: Recommended procedures to be established by The Government for maintenance of lawns during a calendar year. Submit before expiration of required initial maintenance periods.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for lawn, grass, and wildflower growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil.

D. The Government reserves the right to reject, on or after delivery, any material that does not meet these specifications.

E. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.7 PROJECT 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 Substantial Completion.

1. Spring Planting: March 15 – June 15.
2. Fall Planting: September 1 – November 15.
3. Summer Planting: June 15 – September 1 with adequate watering provided by contractor.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 MAINTENANCE SERVICE

A. Initial Lawn Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: 60 days from date of Planting Completion.

    1. When initial maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

2. Sodded Lawns: 30 days from date of Planting Completion.

3. Prairie Grass and Wildflower Areas: One growing season from date of Substantial Completion.

B. Continuing Maintenance Proposal: From Installer to The Government, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Sun and Partial Shade: Proportioned by weight as follows:

1. 50 percent Barrington Tall Fescue (Festuca variety).
2. 50 percent Labarynth RTF Tall Fescue (RTF variety).

2.2 TURFGRASS SOD

A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Sun and Partial Shade: Proportioned by weight as follows:

1. 50 percent Barrington Tall Fescue (Festuca variety).
2. 50 percent Labarynth RTF Tall Fescue (RTF variety).

2.3 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.

B. Provide topsoil from one or more of the following sources as may be required for the Project:

1. Topsoil Source 1: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

1. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.

2. Topsoil Source 2: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.
3. Topsoil Source 3: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

    1. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.

2.4 INORGANIC SOIL AMENDMENTS

A. Provide inorganic soil amendments according to recommendations contained in the Soil Analysis report.

B. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: O, with a minimum of 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through No. 60 (0.25-mm) sieve.
2. Provide lime in form of dolomitic limestone.

C. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through No. 40 (0.425-mm) sieve.

D. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

E. Aluminum Sulfate: Commercial grade, unadulterated.

F. Perlite: Horticultural perlite, soil amendment grade.

G. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

H. Sand: Clean, washed, natural or manufactured, free of toxic materials.

I. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

J. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.5 ORGANIC SOIL AMENDMENTS

A. Provide organic soil amendments according to recommendations contained in the Soil Analysis report.

B. Compost: 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 5 to 1 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.

C. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

D. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.

2.6 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.7 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.8 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; 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.

2.9 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. 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.

2.10 PLANTING SOILS

A. Planting Soil Mix: ASTM D-422, pH range of 5.5 to 7, 3 to 5 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth. Soil shall be a Sandy Loam, with the following characteristics:

Percentage by dry weight:

Clay- 0 - 20%

Silt - 15 - 50%

Sand- 45 - 80%

Grain size and distribution:

Sand content to be 0.075 mm to 0.425 mm in diameter. Grain size distribution for the sand fraction of the soil (ASTM D-422):

Sieve Size	Percent Passing (minimum)
9.5 mm	100%
2.0 mm	90%
0.425 mm	75%

Percolation Rate:

Within the range of 0.6 to 2 in/hr.

Soil Classification:

The USDA (United States Department of Agriculture) classification is Sandy Loam. The USCS (Unified Soil Classification System) is SM

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Provide 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 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off The Government's property.

1. Apply superphosphate fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

    1. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    2. Mix lime with dry soil before mixing fertilizer.

3. Spread planting soil mix to a depth of 6 inches (150 mm) but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    1. Spread approximately 1/2 the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil mix.
    2. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches (150 mm). Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches (150 mm) of soil. Till soil to a homogeneous mixture of fine texture.

    1. Apply superphosphate fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off The Government's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, restore areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Lawn Preparation" Article.

B. 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.

C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft. (1.4 to 1.8 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 as required to suit conditions.

1. 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.
2. 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 depth over seeded areas. Spread by hand, blower, or other suitable equipment.

    1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

E. 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 depth of 3/16 inch (4.8 mm), and roll surface smooth.

3.6 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. 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 subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, 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 angle of slopes exceeding 1:3.

C. 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.

3.7 LAWN RENOVATION

A. Renovate existing lawn where indicated on the drawings or where damaged by contractors operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
2. Provide new planting soil as required.

B. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.

C. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing lawn.

E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off the property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches (150 mm).

H. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches (100 mm) of existing soil. Provide new planting soil to fill low spots and meet finish grades.

I. Apply seed and protect with straw mulch or sod as required for new lawns.

J. Water newly planted areas and keep moist until new lawn is established.

3.8 LAWN MAINTENANCE

A. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.

1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

B. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn 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 lawn with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.

C. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass to a height of 2 to 3 inches (50 to 75 mm).

D. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to lawn area.

3.9 SATISFACTORY LAWNS

A. Lawn installations shall meet the following criteria as determined by Contracting Officer:

1. Satisfactory Seeded Lawn: 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 Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

B. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.10 CLEANUP AND PROTECTION

A. Promptly remove soil and debris, created by lawn work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. 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 lawn is established.

C. Remove nondegradable erosion-control measures after grass establishment period.

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**,** by tree spade or digging and boxing.

B. Related Requirements:
1. Section 329300 "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 at 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, but within tolerance according to ANSI Z60.1.

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. Weed-control barriers.
2. Proprietary Root-Ball-Stabilization Device: One unit.
3. 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. Sample Warranties: For special warranties.

G. 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.

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 when they are dormant:

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. 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.

E. 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 Owner, or incidents that are beyond Contractor's control.
b. Death and unsatisfactory growth are 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 Transplanting Completion:

a. Trees:18 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.

1.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide tree maintenance by skilled employees of tree-service firm and as required in Part 3. Begin maintenance immediately after preparatory pruning and continue until plantings are healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 18 months from date of transplanting completion.

B. Continuing Maintenance Proposal: From tree-service firm to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

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: 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. Planting Soil: Planting soil as specified in Section 32 90 00 "Landscape Planting".

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.

C. Palm Bracing: Battens or blocks, struts, straps, and protective padding as indicated.

   1. Battens or Blocks and Struts: Rough-sawn, sound, new hardwood or softwood, free of knots, holes, cross grain, and other defects, 2-by-4-inch nominal (38-by-89-mm actual) by lengths indicated.
   2. Straps: Adjustable steel or plastic package banding straps.
   3. Padding: Burlap.
   4. Proprietary Palm-Bracing Devices: Proprietary systems to secure each new planting by trunk; sized according to manufacturer's written instructions unless otherwise indicated.

2.4 WATERING DEVICES

A. Watering Pipe: PVC pipe 4 inches (100 mm) in diameter, site-cut to length as required, and with snug-fitting removable cap.

B. Slow-Release Watering Device: Standard product manufactured for drip-irrigation of plants and emptying its water contents over a period of 2 hours; manufactured from UV-light stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

2.5 MISCELLANEOUS PRODUCTS

A. Organic Mulch: Double shredded hardwood as specified in Section 329300 "Plants."

B. Mineral Mulch: Rounded riverbed gravel or smooth-faced stone as specified in Section 329300 "Plants."

C. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

D. Burlap: Non-synthetic, biodegradable.

E. Pesticides: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended in writing 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.

1. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
2. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

F. Weed-Control Barriers:

1. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101 g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.
2. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd. (162 g/sq. m).

G. Wood Preservative Treatment by Pressure Process: AWPA U1; Use Category UC4a, using preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium.

PART 3 - EXECUTION

3.1 TREE-TRANSPLANTING SPECIALIST

A. Tree-Transplanting Specialist Firms: Subject to compliance with requirements, have tree transplanting performed by one of the following firms:
   1. GRO Horticultural Enterprises
      14440 Marengo Road
      Union, IL 60180
      Phone: 847.669.8658
   2. Hendricksen Tree Care
      2131S. Foster Avenue
      Wheeling, IL 60090
      Phone: 847.305.5524

3.2 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. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to transplanting work and tree protection and health.

C. Proceed with transplanting only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, other facilities, turf areas, and other plants and planting areas from damage caused by transplanting operations.

B. Utility Locator Service: Notify utility locator service for area where Project is located before beginning excavation.

C. Locate and clearly identify trees for transplanting. Flag each tree at 54 inches (1372 mm) above the ground.

D. 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.

E. Apply antidesiccant to trees uniformly, using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during extracting, handling, and transportation.

   1. If deciduous trees are moved in full leaf, spray with antidesiccant before extracting and again two weeks after transplanting.

F. Wrap trees with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during extracting, handling, and transporting.

3.4 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 around perimeter of tree at indicated root-ball width to determine locations of main lateral roots.
2. Dig trench by hand 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: 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).

3.5 EXCAVATION AND PLANTING EQUIPMENT

A. Tree Spade: Track-mounted mechanized tree mover; sized according to manufacturer's size recommendation for each tree being transplanted.

3.6 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.

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.

F. Saline or Sodic Soils: Completely fill excavations with water and allow to percolate away before positioning trees.

3.7 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, for each inch (25 mm) of tree caliper being transplanted.

1. Out-of-Season Planting: If planting before or after the in-season period for tree, provide a minimum root-ball diameter of 12 inches (305 mm) 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 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.

3.8 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 bottom of root flare 1 inch (25 mm) 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. Watering Pipe: During backfilling, install watering pipe 4 feet (1220 mm) deep into the planting pit outside the root ball with top of pipe 1 inch (25 mm) above the mulched surface.

H. 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.

I. 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.

3.9 CROWN PRUNING

A. Prune branches as directed by 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.

3.10 TREE STABILIZATION

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as 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 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 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 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 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. Allow enough slack to avoid rigid restraint of tree.
d. Support trees with guy cable, connected to the brass grommets of tree-tie webbing at contact points with tree trunk and reaching to a turnbuckle. 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 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 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 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.

D. Palm Bracing: Install bracing system at three or more places equally spaced around perimeter of trunk to secure each palm until established unless otherwise indicated.

1. Site-Fabricated Palm-Bracing Method:

a. Place battens over padding and secure battens in place around trunk perimeter with at least two straps, tightened to prevent displacement. Ensure that straps do not contact trunk.
b. Place diagonal braces and cut to length. Secure upper ends of diagonal braces with galvanized nails into battens or into nail-attached blocks on battens. Do not drive nails, screws, or other securing devices into palm trunk; do not penetrate palm trunk in any fashion. Secure lower ends of diagonal braces with stakes driven into ground to prevent outward slippage of braces.

2. Proprietary Palm-Bracing Device: Install palm-bracing system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.11 MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches (150 mm) and secure seams with galvanized pins.

B. Organic Mulch: Apply 3-inch (75-mm) average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 6 inches (150 mm) of trunks or stems.

C. Mineral Mulch in Planting Areas: Apply 3-inch (75-mm) average thickness of mineral mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 6 inches (150 mm) of trunks or stems.

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.

3.13 TREE MAINTENANCE

A. Perform tree maintenance as recommended by arborist. Maintain arborist observation of transplanting work.

B. Maintain trees 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. Treat as required to keep trees free of insects and disease.

C. From time of tree extraction measure soil moisture adjacent to edge of each root ball weekly. Record findings and weather conditions.

D. Fill areas of soil subsidence with backfill soil. Replenish mulch materials damaged or lost in areas of subsidence.

E. Apply treatments as required to keep tree materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

F. Pesticide Application: Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

1. Pre-Emergent Herbicides (Selective and Non-Selective): Apply in accordance with manufacturer's written instructions. Do not apply to seeded areas.

2. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.

G. Reports: Have arborist prepare monthly inspection reports.

3.14 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 corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.

1. Provide new trees of same size as those being replaced for each tree of 6 inches (150 mm) or smaller in caliper size.
2. Species of Replacement Trees: Same species being replaced.

3.15 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.

3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Except for materials indicated to be recycled, remove surplus soil, excess excavated material, waste materials, displaced plants, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Except for materials indicated to be retained on Owner's property or recycled, remove excess excavated material, waste materials, displaced plants, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 32 96 00