PROJECT MANUAL

FOR THE CONSTRUCTION OF

PROJECT TCC MOUNTAIN HOME
2356 AR-201
MOUNTAIN HOME, AR 72653

Architect Project Number: 766951-01

November 21th, 2025
(Latest Issue: Revision 1 – 6/10/2026)

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SECTION 012100 - ALLOWANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements governing allowances.

B. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to the Contractor. If necessary, additional requirements will be issued by Change Order.

C. Types of allowances include the following:

1. Testing and inspecting allowances.

D. Related Requirements:

1. Section 014000 "Quality Requirements" for procedures governing the use of allowances for field testing by an independent testing agency.

1.2 SELECTION AND PURCHASE

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

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

C. Purchase products and systems selected by Architect from the designated supplier.

1.3 SUBMITTALS

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

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

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

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

1.4 COORDINATION

A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.5 LUMP SUM ALLOWANCES

A. Allowance shall include cost to Contractor of specific products and materials ordered by Tenant or selected by Architect under allowance and shall include all installation.

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

1.6 TESTING AND INSPECTING ALLOWANCES

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

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

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

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

1.7 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

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

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

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

PART 2 – PRODUCTS: NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 SCHEDULE OF ALLOWANCES

A. Allowance No. 1: $TBD

END OF SECTION 012100

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SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Division 01 Section "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
2. Divisions 02 through 33 Sections for specific requirements and limitations for substitutions.

1.2 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, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Tenant that are not required in order to meet other Project requirements but may offer advantage to Contractor or Tenant.

1.3 ACTION SUBMITTALS

A. Substitution Requests: Via ACC, Submit 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 AIA form or CSI Form – Substitution Request 13.1A**
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication, or installation cannot be provided, if applicable.
b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Tenant and separate contractors, that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects with project names and

addresses and names and addresses of architects and owners.

h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

i. Research reports evidencing compliance with building code in effect for Project, and written acceptance of such from governing authority.

j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

k. Cost information, including a proposal of change, if any, in the Contract Sum.

l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within three days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within seven days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.

b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.4 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.

1.5 PROCEDURES

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

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than thirty (30) days prior to time required for preparation and review of related submittals.

1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:

a. ***Requested substitution has first been approved for submittal by the Tenant construction manager.***
b.. Requested substitution is consistent with the Contract Documents and will produce indicated results.
c. Substitution request is fully documented and properly submitted.
d. Requested substitution will not adversely affect Contractor's construction schedule.
e. Requested substitution has received necessary approvals of authorities having jurisdiction.
f. Requested substitution is compatible with other portions of the work.
g. Requested substitution has been coordinated with other portions of the Work.
h. Requested substitution provides specified warranty.
i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed.

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

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SECTION 013100 - 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 project coordination procedures.
2. Administrative and supervisory personnel.
3. Requests for information (RFIs).
4. Project web site.
5. Project meetings.

B. Related requirements:

1. Section 017000 - Execution and Closeout Requirements
2. Section 017700 - Closeout Procedures

1.3 DEFINITIONS

A. Furnish: (as it pertains to responsibility) To supply and deliver to project site ready for installation

B. Install: (as it pertains to responsibility) To place a furnished item in a final location complete and ready for intended use

C. Provide: (as it pertains to responsibility) To furnish and install, complete and ready for intended use

D. RFI (request for information): Request from Tenant, construction manager, architect, or contractor seeking information from each other during construction.

1.4 COORDINATION

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. Note and account for live operations which vary and are site specific.

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.
9. Project closeout activities.

1.5 REQUESTS FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information or interpretation of the contract documents, contractor shall prepare and submit an RFI in the form specified.

1. Architect will return RFIs submitted to architect by other entities controlled by contractor with no response.
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 and construction manager.
6. RFI number, numbered sequentially.
7. RFI subject.

    a. Only one issue shall be submitted per RFI. RFI’s shall NOT include multiple requests for information within the same RFI number.

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 solution(s) 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: Electronic format, through project web-site with substantially the same content as indicated above, acceptable to architect

D. Architect's action: Architect will review each RFI, determine action required, follow up with Tenant as needed and respond. Allow 3 working days for architect's response for each RFI. RFIs received by architect after 1:00 p.m. (project local time) will be considered as received the following working day.

1. The following RFIs will be returned without action. Return of such RFIs is not an indication of acknowledgement, acceptance or approval:

a. Requests for approval of submittals.
b. Requests for approval of substitutions when disallowed by applicable specification sections.
c. Requests for coordination information already indicated in the contract documents.
d. Requests for adjustments in the contract time or the contract sum.
e. Requests for interpretation of architect's actions on submittals.
f. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case architect's time for response will date from time of receipt of additional information.

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

a. If contractor believes the RFI response warrants change in the contract time or the contract sum, notify architect and Tenant construction manager in writing within 3 working days of receipt of the RFI response. Tenant construction manager must approve said change in order to proceed.

4. On receipt of architect's and Tenant construction manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify architect and construction manager within 3 working days if contractor disagrees with response.

E. RFI log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Update log weekly. Use software log that is part of project web site, with not less than the following:

1. Project name.
2. Name and address of contractor.
3. Name and address of architect and construction manager.
4. RFI number including RFIs that were dropped and not submitted.
5. RFI description.
6. Date the RFI was submitted.
7. Date architect's and construction manager's response was received.

1.6 PROJECT WEBSITE

A. Provide and use “ACC [Construction] Project Management” software and license for purposes of hosting and managing project communication and documentation until final completion. Project web site shall include the following functions:

1. Project directory.
2. Project correspondence
3. Meeting minutes.
4. RFI forms and logs.
5. Task and issue management.

6. Photo documentation.
7. Construction schedule.
8. Submittals forms and logs.
9. Drawing and specification document hosting, viewing, and updating.
10. Online document collaboration.
11. Reminder and tracking functions.
12. Archiving functions.

1.7 PROJECT MEETINGS

A. General: General Contractor (GC) construction manager or GC project manager will schedule and conduct meetings and conferences at project site, unless otherwise indicated.

B. Preconstruction conference: Tenant construction manager or representative will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Tenant and architect prior to date of mobilization, unless otherwise agreed upon.

C. Progress meetings: GC construction manager will conduct progress meetings at agreed upon intervals, discussed at preconstruction conference.

1. Attendees: In addition to representatives of Tenant, Tenant's commissioning authority, construction manager, 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. Verify if additional Tenant representation is needed on meetings/calls.

1.8 REQUIRED SUBMITTALS FOR DESIGN TEAM REVIEW

A. Refer to section 013300 – Submittal Procedures for required submittal list.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION: NOT USED

END OF SECTION 013100

SECTION 013300 – SUBMITTAL AND RFI PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Products include, but are not limited to, the following:
   1. Shop drawings.
   2. Product data.
   3. Samples.
   4. Quality assurance submittals.
   5. Informational submittals.
   6. Other submittals

B. Related Requirements:

   1. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.

   2. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require design professionals 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 design professionals responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. Closeout submittals: Written and graphic information and physical samples that do not require a review. These submittals are only required to be included in the close-out documents.

D. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files. ACC shall be used as the FTP site.

E. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

F. Working Day: Any day other than Saturdays, Sundays, and the following U.S. Holidays:
   1. New Year's Day
   2. Memorial Day
   3. Independence Day
   4. Labor Day
   5. Thanksgiving Day
   6. Christmas Day

1.3 ACTION SUBMITTALS

A. Submittal Schedule: Submit a schedule 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 within 14 days of the date established for commencement of the Work. 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.
    g. Scheduled date of fabrication.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: Electronic digital data files (AutoCAD format) of the following Contract Drawings may be provided by Architect for Contractor's use in preparing submittals.

1. Digital data drawing files:

    a. Overall Floor Plans (“base plans”)
    b. Reflected Ceiling Plans (“base plans”)
    c. Floor Finish Plans (“base plans”)

2. Architect will furnish Contractor one set of digital data drawing files of the indicated Contract Drawings for use in preparing Shop Drawings and Project record drawings.

    a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
    b. Contractor shall fully execute a data licensing agreement to be requested from AOR / EOR prior to receipt of any digital files.

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. This includes shop drawings, product data or any additional details. Both shop drawings and product data must be submitted together.

3. Coordinate transmittal of different types of submittals for related parts of the Work 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 working 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 10 working days for review of each resubmittal.

4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 10 working days for initial review of each submittal.

5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect (or Prime Consultant) and to their sub-consultants, allow 5 working days for review of each submittal and 3 working days for review of each RFI. Submittal will be returned to Architect before being returned to Contractor.

D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single pdf file incorporating submittal requirements of a single Specification Section. Group all applicable submittals as noted below. All Plumbing Fixtures are to be combined into single PDF file, All Lighting are to be combined into single pdf file, etc.

2. Name file beginning with the product identifier (designated specification number), include any, including revision identifier.
    a. File name shall use project identifier and number from mandatory submittals list below in section 3.3 (e.g., 03200 Concrete Reinforcing, 093000 Tiling, etc.). Resubmittals shall be numbered in numerical order (e.g., 01 Concrete_REV 1, 01 Concrete_REV 2, etc.).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.

4. ACC Transmittal Form for Electronic Submittals: Containing the following information:

   a. Project name.
   b. Date.
   c. Name and address of Architect.
   d. Name of Contractor.
   e. Name of firm or entity that prepared submittal.
   f. Names of subcontractor, manufacturer, and supplier.
   g. Category and type of submittal.
   h. Submittal purpose and description.
   i. Specification Section number and title.
   j. Specification paragraph number or drawing designation and generic name for each of multiple items.
   k. Drawing number and detail references, as appropriate.
   l. Location(s) where product is to be installed, as appropriate.
   m. Related physical samples submitted directly.
   n. Indication of full or partial submittal.
   o. Transmittal number numbered consecutively.
   p. Submittal and transmittal distribution record.
   q. Other necessary identification.
   r. Remarks.

5. Metadata: Include the following information as keywords in the electronic submittal file metadata:

   a. Project name.
   b. Number and title of appropriate Specification Section.
   c. Manufacturer name.
   d. Product name.

E. Options: Identify options requiring selection by Architect.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

G. 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.

H. 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.

I. 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.

PART 2 - PRODUCT - NOT USED

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action 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. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, 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.

3.2 ARCHITECT'S ACTION

A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

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

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

D. Submittals not required by the Contract Documents and the mandatory submittal list should not be submitted for review to the Architect or consultant team.

E. Action stamp: the AE will stamp each submittal with a uniform action stamp. The AE will mark the stamp appropriately to indicate the action taken, as follows:

No Exceptions Taken: Work covered by the submittal may proceed provided it complies with requirements of the contract documents. Final acceptance will depend on that compliance.

1. Note Markings: Work covered by the submittal may proceed provided it complies with both the AE's notations or corrections on the submittal and requirements of the contract documents. Final acceptance will depend on that compliance.

2. Revise/Resubmit or Rejected/Resubmit: Do not proceed with the work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the AE's notations. Resubmit without delay. Repeat if necessary, to obtain an “Approved” “Approved as Noted” action mark.

3. Not Required, Not Reviewed: When a submittal is primarily for information or record purposes or for special processing or other contractor activity or is not on the below required submittal list, the submittal will be marked "Not Required, Not Reviewed" and returned without review.

3.3 MANDATORY SUBMITTALS FOR REVIEW OR APPROVAL

A. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single pdf file incorporating submittal requirements of a single Specification Section. Group all applicable submittals as noted below. All Plumbing Fixtures are to be combined into single PDF file, All Lighting are to be combined into single pdf file, etc.

2. Submittals are subject to be rejected if these requirements are not met.

3. Product data is to be submitted with shop drawings and not separately.

B. Shop Drawings and Information will be required as listed below:

1. Concrete
   a. 032000 Concrete Reinforcing
   b. 033000 Cast In Place Concrete
   c. 034713 Tilt-Up Concrete

2. Masonry
   a. 042200 Concrete Unit Masonry

3. Metals
   a. 051200 Structural Steel Framing
   b. 052100 Steel Joist Framing
   c. 053100 Steel Decking
   d. 055000 Metal Fabrications
   e. 055119 Metal Grating Stairs
   f. 055213 Pipe Tube and Railing

4. Woods, Plastics and Composites
   a. 064100 Architectural Wood Casework

5. Thermal and Moisture Protection
   a. 072100 Thermal Insulation

6. Roofing
   a. 074100 Roof Panels
   b. 074113 Standing Seam Roof Panels
   c. 075423 Thermoplastic Polyolefin Roofing
   d. 077220 Roof Accessories

7. Openings
   a. 081113 Hollow Metal Doors and Frames
   b. 083323 Overhead Coiling Doors (no substitutions allowed)
   c. 083613 Sectional Doors (no substitutions allowed)
   d. 084113 Aluminum-Framed Entrances and Storefronts
   e. 087100 Door Hardware

8. Finishes
   a. 09300 Tiling
   b. 095113 Acoustical Panel Ceilings
   c. 096813 Tile Carpeting

9. Specialties
   a. 102800 Toilet Accessories
   b. 104400 Fire Protection Specialties (Fire Alarm and Fire Sprinkler)

10. Equipment
   a. 111300 Loading Dock Equipment (no substitutions allowed)

11. Plumbing
   a. 220010 General Plumbing Requirements
   b. 220500 Common Work Results For Plumbing
   c. 220513 Common Motor Requirements For Plumbing Equipment
   d. 220515 Basic Piping Materials And Methods
   e. 220516 Expansion Fittings And Loops For Plumbing Piping
   f. 220519 Meters And Gauges For Plumbing Piping
   g. 220523 General-Duty Valves For Plumbing Piping
   h. 220529 Hangers And Supports For Plumbing Piping
   i. 220548 Seismic Controls For Plumbing Systems
   j. 220550 Vibration Isolation For Plumbing Piping And Equipment
   k. 220553 Identification For Plumbing Piping And Equipment
   l. 220700 Plumbing Insulation
   m. 221100 Water Distribution Piping And Specialties
   n. 221111 Mechanically Joined Plumbing Piping Systems
   o. 221112 PEX Tubing Water Distribution System And Specialties
   p. 221115 CPVC Water Distribution Systems And Specialties
   q. 221123 Domestic Water Pumps
   r. 221300 Sanitary Drainage And Vent Piping And Specialties
   s. 221328 Condensate Pumps For HVAC Equipment
   t. 221329 Sanitary Sewerage Pumps
   u. 221400 Storm Drainage Piping And Specialties
   v. 221500 General Service Compressed Air Systems
   w. 223300 Electric Domestic Water Heaters
   x. 223400 Fuel Fired Domestic Water Heaters
   y. 223701 Hybrid Heat Pump Domestic Water Heaters
   z. 224000 Plumbing Fixtures
   aa. 227000 Natural Gas Systems

12. Heating, Ventilation and Air Conditioning (HVAC)
   a. 230010 General Mechanical Requirements
   b. 230015 Electrical Coordination For Mechanical Equipment
   c. 230500 Common Work Results For HVAC
   d. 230510 Basic Piping Materials And Methods
   e. 230513 Common Motor Requirements For HVAC Equipment
   f. 230514 Variable Frequency Drives
   g. 230529 Hangers And Supports For HVAC Piping And Equipment
   h. 230548 Seismic Controls For Mechanical Systems
   i. 230550 Vibration Isolation For HVAC
   j. 230553 Identification For HVAC Piping And Equipment
   k. 230593 Testing, Adjusting, And Balancing For HVAC
   l. 230700 HVAC Insulation
   m. 230800 Commissioning Of HVAC Systems
   n. 230900 Instrumentation And Control For HVAC
   o. 230915 Vehicle Emission Monitoring System
   p. 230924 Small Building Control System
   q. 232300 Refrigerant Piping
   r. 233113 Metal Ducts
   s. 233300 Air Duct Accessories

t. 233413 Axial HVAC Fans
u. 233423 HVAC Power Ventilators
v. 233600 Air Terminal Units
w. 233713 Diffusers, Registers & Grilles
x. 233723 HVAC Gravity Ventilators
y. 234100 Particulate Air Filtration
z. 235100 Breechings, Chimneys And Stacks
aa. 235400 Furnaces
bb. 236200 Packaged Compressor And Condenser Units
cc. 237333 Indirect-Fired Heating And Ventilating Units
dd. 237413 Outdoor Packaged Heating And Cooling Units
ee. 237433 Dedicated Outdoor Air Units
ff. 238126 Split System Air Conditioners
gg. 238149 Rooftop Heat Pump Units
hh. 238200 Terminal Heating And Cooling Units
ii. 238500 Electric Heating Units

13. Integrated Automation
    a. 251300 Integrated Automation Systems

14. Electrical
    a. 260010 General Electrical Requirements
    b. 260500 Common Work Results For Electrical
    c. 260502 Equipment Wiring Systems
    d. 260504 Provisions For Electrical Utility Service
    e. 260510 Common Work Results For Communications
    f. 260519 Low-Voltage Electrical Power Conductors And Cables
    g. 260526 Grounding And Bonding For Electrical Systems
    h. 260529 Hangers And Supports For Electrical Systems
    i. 260533 Raceway And Boxes For Electrical Systems
    j. 260543 Underground Ducts And Raceways For Electrical Systems
    k. 260548 Seismic Controls For Electrical Systems
    l. 260553 Identification For Electrical Systems
    m. 260573 Overcurrent Protective Device Coordination Study
    n. 260923 Lighting Control Devices
    o. 262200 Low-Voltage Transformers
    p. 262413 Switchboards
    q. 262416 Panelboards
    r. 262600 Power Distribution Units
    s. 262713 Electricity Metering
    t. 262726 Wiring Devices
    u. 262813 Fuses
    v. 262816 Enclosed Switches And Circuit Breakers
    w. 264113 Lightning Protection
    x. 264313 Surge Protective Devices
    y. 265100 Interior Lighting
    z. 265600 Exterior Lighting

15. Exterior Improvements
    a. 323113 Chain Link Fences And Gates
    b. 323300 Site Furnishings

16. Utilities

C. For any submittals submitted for review that are not included on this list, they will be returned and marked, “Not Required, Not Reviewed”.

3.4 SUBMITTAL & RFI PROCEDURES

A. Sequentially number the transmittal form. Resubmittals shall be numbered in numerical order (e.g., 01 Concrete_REV 1, 01 Concrete_REV 2, etc.).

B. Identify Project, Contractor, Subcontractor or Supplier, pertinent drawing and detail number, and specification section number, as appropriate on each copy.

C. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.

D. Upload submittals to specific design discipline. Mechanical submittals should be submitted to mechanical engineer, structural submittals should be submitted to the structural engineer, ect. Only send consultant submittals to Architect if a simultaneous review by the architect is required on the submittal. If there are any questions, contact Owner Construction Manager for assistance.

E. Schedule submittals to expedite the Project, and coordinate submission of related items. Once the contract is awarded, it is the expectation by the Owner that that contractor begins submitting all required submittals. Do not wait till close to construction or concrete pour for example to submit necessary submittal.

F. For each submittal for review, allow 10 business days excluding delivery time to and from the Contractor.

G. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

H. Provide space for Contractor and Owner's Representative review stamps.

I. When revised for resubmission, identify all changes made since previous submission.

J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

1. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

2. Submit Shop Drawings in PDF electronic format.

K. Samples: Physical samples are not required for any mandatory submittal. For paint colors, please provide a single photo aht includes a paint sample of the specified product next to the product being suppled, on white paper with natural lightings for review and approval. When providing the specified products, no samples are required.

L. 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.

5. Submit Shop Drawings in PDF electronic following format:

M. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."

N. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

O. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."

P. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."

Q. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

3.5 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.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file and three paper copies 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.

END OF SECTION 013300

SECTION 013329 – SUSTAINABLE DESIGN REQUIREMENTS AND REPORTING

PART 1 - GENERAL

1.1 SUMMARY

A. This project supports Owner goals to design, construct, and operate zero/low carbon, healthy, and resource efficient buildings. Contractor will support these goals with reporting of construction waste diversion, procurement of low-carbon and healthy building materials, and reporting material quantities and associated carbon emissions through a Bill of Materials (BOM). Contractor shall follow Client's standards for asset tagging of installed equipment.

B. Related Requirements:

1. Section 015721 – Construction Indoor Air Quality Controls
2. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.2 SUSTAINABILITY COORDINATOR

A. A member from the construction team shall be designated to support reporting of Construction Waste Management (CWM), Construction Indoor Air Quality Controls, tracking of EPDs and provide a Bill of Materials.

1.3 ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

A. Provide EPDs for all major building materials and report EPDs through the Embodied Carbon in Construction (EC3) tool, if not already in the system. EPDs are required, at a minimum, for all core and shell materials, permanent site materials, and major finishes (those included in the Design Criteria).

1. EPDs shall be product-specific, current and third-party verified.
2. Industry- wide material- specific EPDs are acceptable as an alternate, only when product-specific EPDs are not available.
3. All EPDs shall comply with ISO 14025, 14040, 14044, EN 15804 or ISO 21930.

1.4 WOOD SYSTEMS

A. All rough carpentry wood shall be FSC or SFI Certified from the Forest Stewardship (FSC) or Sustainable Forestry Initiative (SFI). All composite wood based materials or assemblies shall have no added urea formaldehyde (NAUF), or be ultra-low emitting formaldehyde (ULEF) compliant, when NAF Standard (No Added Formaldehyde) is not available. The use of alternate products that are salvaged, sustainably harvested or meet stringent low-emissions criteria shall be coordinated with the Owner Project team as needed. Ensure that FSC or SFI Chain-of-custody (COC) certificates are submitted from qualified manufacturers, fabricators, or suppliers before products are purchased.

1.5 RECYCLED CONTENT

A. A member from the construction team shall be designated to support reporting of Construction Waste Management (CWM), Construction Indoor Air Quality Controls, tracking of EPDs and provide a Bill of Materials.

1.6 REGIONAL MATERIALS

A. To the greatest extent possible, materials shall be extracted, harvested and manufactured regionally, within 100 miles of the Project site, and/or with the lowest transportation emissions from manufacturer to the Project site.

1.7 HEALTHY MATERIALS

A. Materials shall be selected to avoid persistent toxins and protect the health of both construction team workers and building occupants. Project shall adhere to the low volatile organic compound (VOC) guidelines in this specification and not exceed limits stated in Section 01 6116 for all on-site wet applied items and permanent finishes (e.g., carpet, insulation, acoustical ceiling, wall panels, and resilient flooring). For all permanent building materials, preference shall be given to products with current health product disclosures (Declare, Cradle to Cradle, Health Product Declarations/HPD, etc.) and are Red List compliant.

1.8 DESIGN REPORTING

A. Where an Environmental Product Declaration (EPD) is specified, submit EPDs into the EC3 online tool. https://www.buildingtransparency.org/ Require sub-contractors to source products with EPDs (can use 'find material' function in EC3, and product manufacturer websites) and request EPDs from suppliers when EPD does not yet exist.

B. The Sustainability Coordinator shall provide a complete BOM for all permanently installed material quantities and associated carbon emissions. BOM to be provided at closeout both online in EC3 tool and through single offline report-out. The Project team shall coordinate with the Client Construction Manager should more regular updates be required.

C. Monthly Status Report must be submitted to Tenant which will include current and updated schedule, percentage complete, weather records, progress report defining outstanding issues, tenant issues, pending changes, progress and aerial photos, and other issues related to the Project.

D. Monthly reports will be required to provide updates on the Project sustainability measures as described below:

1. Indoor Air Quality (IAQ) Management –Provide monthly photographs of construction IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials. Photographs must document IAQ measures in place during the entire construction process (defined as work inside the vapor barrier).

2. Construction Waste Management (CWM) - Document monthly Waste Disposal Reports and hauling / tipping receipts associated with all demolition, landfill disposal, recycling, salvage, and reuse. All waste or materials exiting the property must be reported regardless of to whom the costs or savings accrue. Units of measure must be consistent on all reports; unit of tons is preferred. Report shall show both totals to date and since last report. Include the following information:
   a. Material Category
   b. Source of waste
   c. Total quantity of waste in tons
   d. Quantity of waste salvaged in tons.
   e. Quantity of waste recycled in tons.
   f. Total quantity of waste recovered (salvage plus recycled) as a percentage of total waste.
   g. Include up-to-date records of donations, sales, recycling and landfill manifests, weight tickets, hauling receipts, and invoices.

3. Refrigerant Log – Any equipment containing greater than five pounds of refrigerant, procured or installed under this contract shall be catalogued (tagged) so that Tenant can identify and verify all installed equipment.
    a. Tenant's Enterprise Asset Management standards must be followed for asset tagging of installed equipment. Tagging shall be complete before Project handover to Owner.
    b. If the Tenant Precon team or Construction Manager (CM) hires a 3P Commissioning Provider (CxP), the Installation and Operation Qualifications (IOQ) team should review the Cx requirements and coordinate what is not in the CxP's purview. In this case, asset tagging must be completed before functional testing of equipment begins.
    c. c. Equipment containing refrigerant shall have its location, manufacturer, model number, model year, serial number, refrigerant charge, cooling capacity, and type of refrigerant collected as key parameters in a format designated by the owner, for evaluation against refrigerant tracking requirements.
    d. d. Following system activation, refrigerant use, leak detection/repair/verification, and leak inspections shall be tracked on a frequency as mandated by applicable local, State, Federal,and/or Country specific regulations, OR Tenant's requirements in conjunction with the Reliability & Maintenance Engineering (RME) team.
4. Scope 3 Carbon Emissions Tracking - Provide for a complete Bill of Materials (BOM) to include: building materials, material quantities, and associated carbon emissions through the Embodied Carbon in Construction (EC3) tool. The complete BOM is to be provided to Tenant Construction Manager at closeout using both the online EC3 Tool and a single documented report. EPDs are required, at a minimum, for all core and shell materials, permanent site materials, and major finishes (those included in the Design Criteria).
    a. EPDs shall be product and facility-specific.
    b. Industry-wide material- specific EPDs are acceptable as an alternate, only when product and facility-specific EPDs are not available.
5. All EPDs shall be third-party verified to comply with ISO 14025, 14040, 14044, EN 15804 or ISO 21930. Where an Environmental Product Declaration (EPD) is specified, submit EPDs into the EC3 online tool.
6. Sub-contractors to source products with EPDs (using 'find material' function in EC3, and product manufacturer websites) and request EPDs from suppliers if EPD does not exist. The Project team shall coordinate with the Tenant Construction Manager should more regular updates be required for reporting.

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 013329

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SECTION 013500 - SPECIAL PROCEDURES

PART 1 - GENERAL

1.1 FIRE PROTECTION

A. Regulations: The contractor shall comply with any & all city or authority have jurisdiction regulations regarding fire safety in welding and cutting operations and fire prevention during building construction operations.

B. Any impairments of the fire protection system must be coordinated with local Tenant site specific leadership. Notify Fire Marshall and put Fire Alarm in test mode.

C. Welding and cutting: It shall be the responsibility of the contractor to contact the Tenant safety project manager at the beginning of the project to understand requirements to obtain a “hot work permit” for use during the project. It shall be the responsibility of the contractor to notify the Tenant project manager in advance of the work when welding or other fire hazardous work is to be performed and to take precautionary measures to prevent fire.

D. Chemicals: The GC will ensure that all chemicals are properly stored and are removed from the worksite at the conclusion of the project.

1.2 ASBESTOS REMOVAL

A. Remove prior to construction: Any area within the space that is to be remodeled must be inspected for the presence of asbestos containing building materials (ACBMs) prior to commencement of work activities. No construction activities may disturb ACBMs, no work shall be allowed in an area containing suspected ACBMs material until it has been removed by a certified contractor or certified as not friable and will not be impacted by any construction activities. The Tenant project manager must be informed in advance of any abatement or removal of asbestos on the project site.

1.3 SITE SECURITY

A. Daily inspection: Full-time security guard will not be specifically required, but the contractor shall provide inspection of the building and site daily while the work is in progress and shall take whatever measures are necessary to secure the building from theft, vandalism and unauthorized entry.

1.4 UTILITY LOCATE PROCEDURE

A. Call before you dig: Before performing any excavation on site, notify the project manager at least 14 calendar days in advance. The contractor will check with facilitates and/or campus utilities, etc. And respond to the contractor.

B. Excavation: Excavation means any operation in which earth, rock, or other material in or on the ground is moved, removed, or otherwise displaced by means of any tools, power equipment, and includes, without limitation, grading, trenching, digging, ditching, drilling, auguring, boring, tunneling, scraping, cable or pipe plowing, and driving.

C. Jurisdictional requirements: GC & project manager are responsible for confirming & meeting all local or state requirements for excavation and utility location procedures prior to the start of construction.

1.5 UTILITY AND BUILDING SYSTEM OUTAGE PROCEDURE

A. General:

1. 14 days' notice: Outages for building systems and utilities shall be scheduled at least 14 calendar days in advance, at the convenience of the continuing operations of the building and/or site. Landlord approval may be required and may take over 20 days. Significant advanced planning is necessary when an outage is required.

2. Costs incurred: New construction and remodeling projects shall fund all costs incurred in operating systems to accommodate any scheduled or unscheduled outages. Small project remodeling shall have costs and funding approved by all necessary project & building representatives.

B. Planning:

1. Contractor to contact AMOC and the RME Regional Portfolio Manager to coordinate equipment shutdown. Follow RME Standard work document.

2. Provide necessary information: When requesting the outage, the contractor shall include, as a minimum, the following:

a. Project contact person, including telephone
b. Type of outage and specific systems affected
c. Building or specific areas within buildings affected
d. Date and time of outage
e. Length of outage
f. Specific reason for outage

C. Execution:

1. Begin work promptly: The contractor shall agree to start work promptly as scheduled.
2. Cancellation of outage: In the event that the contractor's required material or labor is not available, or other significant problems arise at the scheduled starting time, the project manager reserves the right to cancel the outage.

1.6 TRAFFIC CLOSURES

A. Closure notice required: The contractor is responsible for notifying and obtaining any required permits for the closing of street or sidewalk. The contractor will notify the project manager 14 working days in advance of an impending closure of any streets, bike paths, walks, parking areas, loading docks, or other traffic ways to vehicular or pedestrian traffic.

B. Two week notice, minimum: Closure notice requests shall be completed and submitted for approval at least two (2) weeks prior to the actual closure date to allow public safety units, transit, and others time to plan their emergency, temporary service routes. This process should be followed as far in advance as practical.

C. Delay of work: Projects may be delayed if closure notice request forms are not received in a timeframe so as to provide proper lead-time.

D. Traffic flow: Substantial and permanent changes to parking and/or traffic flow require Tenant WHS approval and may require landlord approval.

1.7 GENERAL SAFETY

A. The project will adhere to all applicable worker safety and workplace safety regulations (ie OSHA or state safety regulations) for the tasks being performed. Violations may result in work interruptions.

B. All contractors are required to assess risks to determine appropriate PPE required for the tasks and supply such equipment.

C. The GC will abide by the requirements of the Tenant's contractor WHS management procedure North America,

D. The GC will ensure safety data sheets for all materials used on this project are provided to Tenant's WHS.

E. The GC will notify Tenant in the event that there has been an OSHA recordable injury to a worker on the project or a serious near miss event with the project. A copy of the report and corrective actions will be provided to Tenant within 24 hours. In the event that there is a serious injury (death, admission to hospital, loss of eye or amputation) the GC will notify Tenant as soon as they are aware of the severity of the injury.

F. The GC will make arrangements to provide for the first aid and medical treatment of any contractor personnel on the project. It should not be anticipated that the Tenant will provide such services.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION: NOT USED

END OF SECTION 013500

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SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. References and standards.
2. Control of installation.
3. Testing and inspection services.
4. Manufacturer's field services.

B. Related Requirements:

1. Section 013300 - Submittal procedures.
2. Section 016000 - Product Requirements: Requirements for material and product quality.

1.2 REFERENCE STANDARDS

A. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

B. ASTM C1093 - Standard Practice for Accreditation of Testing Agencies for Masonry

C. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

E. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing

1.3 TESTING AND INSPECTION AGENCIES

A. General Contractor will employ and pay for services of a third party, independent testing agency to perform specified testing and inspection.

1. Soils compaction.
2. Paving (Concrete/Asphalt)
3. Concrete Testing and Placement, (including Tilt-Up Wall Panels).
4. Foundations
5. Reinforcing steel.
6. Floor flatness and levelness.
7. Masonry
8. Structural steel welds.
9. Structural bolts.
10. Metal deck attachments.

B. General Contractor shall employ and pay for services of a third party, independent Roofing Consultant to review roof submittals, attend pre-roofing meeting, provide on-site inspections (minimum of 1 trip per week) and provide Punch List. Inspections shall be performed by a Registered Roof Observer (RRO) as recognized by the

Roofing Consultants Institute.

C. As indicated in individual specification sections, General Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.

D. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

E. Testing Agency Requirements:

1. Testing agency: Comply with requirements of ASTM E329, ASTM E543, ASTM C1077, and ASTM C1093.
2. Inspection agency: Comply with requirements of ASTM D3740 and ASTM E329.
3. Testing Equipment: Calibrated at reasonable intervals either by NIST or using an NIST established Measurement Assurance Program, under a laboratory measurement quality assurance program.
4. Reports of all tests shall be signed by a qualified individual, having professional registration in the state in which the project is being constructed.

1.4 QUALITY ASSURANCE

A. Environmental product declaration (EPD): publicly available, critically reviewed life cycle analysis having at least a cradle-to-gate scope.

1. Good: Product-specific; compliant with ISO 14044.
2. Better: Industry-wide, generic; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
3. Best: Commercial-product-specific; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; type III third- party certification with external verification, in which the manufacturer is recognized as the program operator.
4. Where demonstration of impact reduction below industry average is required, submit both industry-wide and commercial-product-specific declarations; or submit at least 5 declarations for products of the same type by other manufacturers in the same industry

B. Greenscreen chemical hazard analysis: all ingredients of 100 parts-per-million or greater evaluated using greenscreen for safer chemicals method v1.2.

1. Good: Greenscreen list translator evaluation to identify benchmark 1 hazards; a health product declaration includes this information.
2. Better: Greenscreen full assessment.
3. Best: Greenscreen full assessment by greenscreen licensed profiler.
4. Acceptable evidence: Greenscreen report.

PART 2 - PRODUCTS - NOT USED

PART 3 – EXECUTION

3.1 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have Work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.2 TESTING AND INSPECTION

A. Testing Agency Duties:

1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
2. Perform specified sampling and testing of products in accordance with specified standards.
3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
5. Perform additional tests and inspections required by Architect.
6. Attend preconstruction meetings and progress meetings as required.
7. Testing Agency shall promptly process and distribute all copies of test reports and related instructions to ensure that all necessary retesting and/or replacement of materials can be accomplished without possible delay to progress of the work. The Testing Agency shall provide a written report within three (3) days related to every project test and inspection. Distribute copies to each of the following:

    a. Owner
    b. Architect
    c. Structural Engineer
    d. Contractor
    e. Building Official (if required)

B. Limits on Testing/Inspection Agency Authority:

1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Agency may not approve or accept any portion of the Work.
3. Agency may not assume any duties of Contractor.
4. Agency has no authority to stop the Work.

C. Contractor Responsibilities:

1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
2. Provide Testing Agency with copies of the following shop drawings prior to start of work:

    a. Asphalt mix designs.
    b. Concrete mix designs.
    c. Masonry grout/mortar mix designs.

d. Structural including steel, reinforcing, masonry.
e. Roofing shop drawings.

3. Cooperate with laboratory personnel and provide access to the Work.
4. Provide incidental labor and facilities:

a. To provide access to Work to be tested/inspected.
b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
c. To facilitate tests/inspections.
d. To provide storage and curing of test samples.

5. Notify the Testing Agency a minimum of 48 hours in advance of operations to allow for Testing Agency assignment of personnel and scheduling of tests.
6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

D. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency. Payment for retesting will be charged to the Contractor by deducting testing charges from the Contract Price.

3.3 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.4 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not conforming to specified requirements.

B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct an appropriate remedy or adjust payment.

END OF SECTION 014000

SECTION 014200 - 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 indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
11. AF&PA - American Forest & Paper Association; www.afandpa.org.
12. AGA - American Gas Association; www.aga.org.
13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
15. AI - Asphalt Institute; www.asphaltinstitute.org.
16. AIA - American Institute of Architects (The); www.aia.org.
17. AISC - American Institute of Steel Construction; www.aisc.org.
18. AISI - American Iron and Steel Institute; www.steel.org.
19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
21. ANSI - American National Standards Institute; www.ansi.org.
22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.

39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWPA - American Wood Protection Association; www.awpa.com.
41. AWS - American Welding Society; www.aws.org.
42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CE - Conformite Europeenne; http://ec.europa.eu/growth/single-market/ce-marking/.
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.pbmdf.com.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - CSA Group; www.csagroup.com.
65. CSA - CSA International; www.csa-international.org.
66. CSI - Construction Specifications Institute (The); www.csinet.org.
67. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).
73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. ECIA - Electronic Components Industry Association; www.eciaonline.org.
75. EIA - Electronic Industries Alliance; (See TIA).
76. EIMA - EIFS Industry Members Association; www.eima.com.
77. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. ETL - Intertek (See Intertek); www.intertek.com.
81. EVO - Efficiency Valuation Organization; www.evo-world.org.
82. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
83. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
84. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
85. FM Approvals - FM Approvals LLC; www.fmglobal.com.
86. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
87. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridaroof.com.
88. FSA - Fluid Sealing Association; www.fluidsealing.com.

89. FSC - Forest Stewardship Council U.S.; www.fscus.org.
90. GA - Gypsum Association; www.gypsum.org.
91. GANA - Glass Association of North America; www.glasswebsite.com.
92. GS - Green Seal; www.greenseal.org.
93. HI - Hydraulic Institute; www.pumps.org.
94. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
96. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
97. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
98. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
99. IAS - International Accreditation Service; www.iasonline.org.
100. ICBO - International Conference of Building Officials; (See ICC).
101. ICC - International Code Council; www.iccsafe.org.
102. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
103. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
104. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
105. IEC - International Electrotechnical Commission; www.iec.ch.
106. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
107. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
108. IESNA - Illuminating Engineering Society of North America; (See IES).
109. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
110. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
111. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
112. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
113. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
114. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
115. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
116. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
117. ISO - International Organization for Standardization; www.iso.org.
118. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
119. ITU - International Telecommunication Union; www.itu.int/home.
120. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
121. LMA - Laminating Materials Association; (See CPA).
122. LPI - Lightning Protection Institute; www.lightning.org.
123. MBMA - Metal Building Manufacturers Association; www.mbma.com.
124. MCA - Metal Construction Association; www.metalconstruction.org.
125. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
126. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
127. MHIA - Material Handling Industry of America; www.mhia.org.
128. MIA - Marble Institute of America; www.marble-institute.com.
129. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
130. MPI - Master Painters Institute; www.paintinfo.com.
131. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
132. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
133. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
134. NADCA - National Air Duct Cleaners Association; www.nadca.com.
135. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
136. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
137. NBI - New Buildings Institute; www.newbuildings.org.
138. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.

139. NCMA - National Concrete Masonry Association; www.ncma.org.
140. NEBB - National Environmental Balancing Bureau; www.nebb.org.
141. NECA - National Electrical Contractors Association; www.necanet.org.
142. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
143. NEMA - National Electrical Manufacturers Association; www.nema.org.
144. NETA - InterNational Electrical Testing Association; www.netaworld.org.
145. NFHS - National Federation of State High School Associations; www.nfhs.org.
146. NFPA - National Fire Protection Association; www.nfpa.org.
147. NFPA - NFPA International; (See NFPA).
148. NFRC - National Fenestration Rating Council; www.nfrc.org.
149. NHLA - National Hardwood Lumber Association; www.nhla.com.
150. NLGA - National Lumber Grades Authority; www.nlga.org.
151. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
152. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
153. NRCA - National Roofing Contractors Association; www.nrca.net.
154. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
155. NSF - NSF International; www.nsf.org.
156. NSPE - National Society of Professional Engineers; www.nspe.org.
157. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
158. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
159. NWFA - National Wood Flooring Association; www.nwfa.org.
160. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
161. PDI - Plumbing & Drainage Institute; www.pdionline.org.
162. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
163. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
164. RFCI - Resilient Floor Covering Institute; www.rfci.com.
165. RIS - Redwood Inspection Service; www.redwoodinspection.com.
166. SAE - SAE International; www.sae.org.
167. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
168. SDI - Steel Deck Institute; www.sdi.org.
169. SDI - Steel Door Institute; www.steeldoor.org.
170. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
171. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
172. SIA - Security Industry Association; www.siaonline.org.
173. SJI - Steel Joist Institute; www.steeljoist.org.
174. SMA - Screen Manufacturers Association; www.smainfo.org.
175. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
176. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
177. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
178. SPIB - Southern Pine Inspection Bureau; www.spib.org.
179. SPRI - Single Ply Roofing Industry; www.spri.org.
180. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
181. SSINA - Specialty Steel Industry of North America; www.ssina.com.
182. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
183. STI - Steel Tank Institute; www.steeltank.com.
184. SWI - Steel Window Institute; www.steelwindows.com.
185. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
186. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
187. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
188. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
189. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.

190. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
191. TMS - The Masonry Society; www.masonrysociety.org.
192. TPI - Truss Plate Institute; www.tpinst.org.
193. TPI - Turfgrass Producers International; www.turfgrasssod.org.
194. TRI - Tile Roofing Institute; www.tileroofing.org.
195. UL - Underwriters Laboratories Inc.; www.ul.com.
196. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
197. USAV - USA Volleyball; www.usavolleyball.org.
198. USGBC - U.S. Green Building Council; www.usgbc.org.
199. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
200. WA - Wallcoverings Association; www.wallcoverings.org.
201. WASTEC - Waste Equipment Technology Association; www.wastec.org.
202. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
203. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
204. WDMA - Window & Door Manufacturers Association; www.wdma.com.
205. WI - Woodwork Institute; www.wicnet.org.
206. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
207. WWPA - Western Wood Products Association; www.wwpa.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. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. 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. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov/fdsys.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeial Convention; www.usp.org.

19. USPS - United States Postal Service; www.usps.com.

D. State 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. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
3. CDHS; California Department of Health Services; (See CDPH).
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforestservice.tamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

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SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Temporary utilities.
2. Temporary Telecommunications Services.
3. Temporary Sanity Facilities.
4. Temporary Lighting.
5. Temporary Heating.
6. Temporary Ventilation.
7. Vehicular Access and Parking.
8. Temporary Barriers and Enclosures.
9. Project Identification Sign.
10. Field Offices.
11. Waste Removal Facilities and Services.

1.2 DESCRIPTION OF TEMPORARY UTILITY SYSTEMS

A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.

B. Provide temporary electrical service, including extensions and connections necessary for construction work. Pay costs of installing and maintaining service for duration of project. Pay costs associated with use of permanent electrical system until Date of Substantial Completion.

C. Provide temporary water for construction purposes, including extensions and connections necessary for work. Pay costs of installing and maintaining service for duration of project. Pay costs associated with use of permanent water system until Date of Substantial Completion.

1.3 TEMPORARY TELECOMMUNICATIONS SERVICES

A. Provide, maintain, and pay for local telephone service to field office at time of project mobilization.

B. Telecommunications services shall include:

1. Telephone Land Lines: One line, minimum; one handset per line.
2. Internet Connections: Minimum of one; DSL modem or faster.

1.4 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.

B. New permanent facilities may not be used during construction operations.

C. Maintain daily in clean and sanitary condition.

1.5 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. If project work requires outage of any exterior lighting, including building, sidewalk, or street lighting, adequate temporary lighting shall be provided for the entire duration of the outage as part of the project. Temporary lighting shall be approved by WHS/safety team.

1.6 TEMPORARY HEATING

A. Provide temporary heating in enclosed areas throughout construction period in order to:

1. Facilitate progress of work by all contractors.
2. Protect work and products against dampness and cold.
3. Prevent moisture condensation on surfaces.
4. Provide specified ambient temperatures for installation and curing of finish materials.

B. Heat office areas as specified in the contract documents.

C. Minimum heating temperatures:

1. Minimum temperatures shall be at least that specified in specific specifications sections.
2. Unless otherwise specified, areas in temporary enclosures shall be maintained at temperatures between 45 degrees F and 65 degrees F, 24 hours per day, seven days per week.
3. Unless otherwise specified, areas in permanent enclosures or during placement of interior finishes (woodwork, flooring, painting, drywall, ceilings, etc.) shall be maintained at temperatures between 60 degrees F and not to exceed 70 degrees F, 24 hours per day, 7 days per week.

1.7 TEMPORARY VENTILATION

A. Provide specified temporary ventilation in enclosed areas throughout construction period to:

1. Facilitate progress of work.
2. Protect work and products against dampness and heat.
3. Prevent moisture and condensation on surfaces.
4. Provide suitable ventilation for installation and curing of finish materials.
5. Provide adequate ventilating to meet health regulations for safe working environment.
6. Prevent hazardous accumulations of dusts, fumes, mists, vapors, or gasses in areas occupied during construction.

B. Duration of ventilating operations:

1. At all times personnel occupy an area, when subject to hazardous accumulations of harmful elements.
2. Weekly IAQ testing for contaminants may be required by the Tenant to determine necessary continuing operation of ventilating system after cessation of work to assure removal of harmful elements.
3. Continue until final air clearance (for asbestos abatement projects).

1.8 TEMPORARY METER

A. If it is not possible to use the building's meter, a temporary meter shall be installed. This temporary meter shall meet the reliability and accuracy requirements of the Tenant as specified in the contract documents and will be subject to verification by the Tenant.

1.9 USE OF PERMANENT AIR HANDLING UNIT (AHU) SYSTEMS FOR CONSTRUCTION PURPOSES

A. The use of permanently installed air handling units (AHUs) for temporary ventilating, heating, and cooling during construction is only permitted as specified in the contract documents.

B. See Section 017600 - Protecting Installed Construction for basic requirements that shall be met if permanent equipment is permitted to be used.

1.10 SAFEGUARDS DURING CONSTRUCTION

A. Construct and maintain in accord with local building codes and OSHA regulations.

B. Temporary Controls: determine methods and procedures to be used and assume responsibility for proper protection and safety of all personnel, site, adjoining areas and structures, and public during all phases of the work. Provide all necessary boarding and fencing around all open excavation as required by applicable codes, by-laws, or governing authorities.

1.11 TEMPORARY BARRIERS AND ENCLOSURES

A. Use of barriers and enclosures: the contractor shall furnish, erect and maintain temporary barriers, barricades, enclosures, and temporary construction fencing as required for the following:

1. To protect the health and safety of occupants and the general public from exposure to immediate physical harm as well as to noise, dust, and fumes. Note that this section does not provide minimum requirements related to indoor air quality.
2. To protect new and pre-existing adjacent construction from exposure to physical damage, dust, dirt, and water.
3. To provide security of valuable property.
4. To protect trees and plants.
5. To provide separation between live operations and construction work.

1.12 PROJECT IDENTIFICATION

A. Construct a project sign of 3/4" thick AC plywood, approximately 4'-0" x 8'-0" painted in not more than four (4) colors, supported by 4" x 4" wood posts buried in ground 3'-0" minimum. Coordinate information required for project site with authority having jurisdiction.

B. Erect on site at location established by Tenant Construction Manager.

C. No other signs are allowed without Tenant permission except those required by law.

1.13 FIELD OFFICES

A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture.

B. Provide space for Project meetings, with table and chairs to accommodate attendees.

1.14 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Relocate temporary facilities during construction as required by progress of the Work at no additional cost to the Tenant.

B. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.

1.15 WASTE REMOVAL

A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

1.16 CONSTRUCTION INDOOR AIR QUALITY CONTROLS

A. Create and implement a Construction Indoor Air Quality (IAQ) Management Plan to support construction team and future occupant health.

B. Develop and implement a Construction Indoor Air Quality Management Plan that meets or exceeds the minimum requirements identified below:

1. Protect absorptive materials stored or installed on-site from moisture damage.
2. Limit the generation of dust on-site by maximizing off-site fabrication, using wet cutting equipment and/or establishing cut stations with dust containment.
3. Use filtration media at each return air grill if air handling systems are to be used during construction.
4. Smoking on site, including the use of e-cigarettes, and use of tobacco products is prohibited inside the building during construction. Smoking outside the building is prohibited except in designated smoking areas located at least 25 feet from all entries, outdoor air intakes, and operable windows.

C. Auxiliary Air Filters:

1. If air handlers must be used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 must be used at each return air grill.
2. After construction ends, and prior to occupancy, replace filtration media with new Minimum Efficiency Reporting Value (MERV) 13 filtration media.

PART 2 - PRODUCTS

2.1 TEMPORARY BARRIERS AND ENCLOSURES - GENERAL FABRICATION

A. Substantial construction: Barriers and enclosures shall be of adequately substantial construction to serve their purpose without failure throughout the duration of their use. Materials may be new or used, suitable for the intended purpose, but shall not violate requirements of applicable codes and standards.

B. Rigid fencing: The general public, as well as adjacent lawns and plantings, shall be protected from harm by the installation of continuous, durable, rigid fencing at the limit lines of each construction area.

C. Tree protection: Existing trees that are adjacent to a construction site shall be protected from damage by the installation of durable, rigid 6 foot high fencing at the drip line of each tree.

PART 3 - EXECUTION

3.1 TEMPORARY BARRIERS AND ENCLOSURES - BASIC REQUIREMENTS

A. Install facilities of a neat and reasonable uniform appearance, structurally adequate for required purposes.

B. Install barriers and enclosures so as to not create new hazards such as tripping or protrusions that might be a source of safety concern to pedestrians or passersby.

C. Establish reasonable alternative access when necessary due to placement of barriers. Fenced construction areas within the site will have access points to ensure that egress routes are not impaired.

D. Maintain barriers during entire construction period.

E. Relocate barriers as required by progress of construction.

F. Coordinate safety signage requirements with Tenant's safety representative.

G. Work occurring within the fenced construction areas shall not pose physical or environmental hazards to Tenant's associates occupying the facility. This includes items such as no elevated work (manlifts or high lift trucks) within 20 feet of the inside perimeter of the fence line unless provisions are in place to prevent hazards on the Tenant occupied side of the fence.

1. This includes hazards due to any internal combustion equipment utilized inside, which must be monitored to ensure safety from carbon monoxide.
2. If work will occur outside the fenced construction area the GC will reference the Tenant WHS contractor safety management procedure for additional pre-task, training, and safety precautions that will be required, such as utilizing a spotter for any powered industrial trucks and providing for a 20 foot protective radius around any elevated equipment (manlifts, powered industrial tucks, cranes, etc).

3.2 TREE AND PLANT PROTECTION REQUIREMENTS

A. Preserve and protect existing trees and plants at site which are designed to remain, and those adjacent to site.

B. Consult with Tenant construction manager or Owner's representative for removal of agreed-on roots and branches which interfere with construction.

C. Provide temporary barriers to a height of six feet, around each, or around each group, of trees and plants. The barriers shall be placed at the drip line of each tree.

D. Protect root zones of trees and plants:

1. Do not allow vehicular traffic or parking.
2. Do not store materials or products.
3. Prevent dumping of refuse or chemically injurious materials or liquids.
4. Prevent puddling or continuous running water.

E. Carefully supervise excavating, grading and filling, and subsequent construction operations, to prevent damage.

F. Replace, or suitably repair, trees and plants designated to remain which are damaged or destroyed due to construction operations. Any damage and any necessary replacements will be evaluated by Tenant construction manager and building or campus facilities management.

3.3 REMOVAL

A. Completely remove barricades, including foundations, when construction has progressed to the point that they are no longer needed, and when approved by the Tenant construction manager.

B. Clean and repair damage caused by installation, fill and grade areas of the site to required elevations and slopes and clean the area.

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 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 012500 "Substitution Procedures" for requests for substitutions.
2. Section 013329 “Sustainable Design Requirements and Reporting”
3. Section 014000 “Quality Requirements” for Product quality monitoring.
4. Section 014200 "References" for applicable industry standards for products specified.
5. Section 017700 “Closeout Procedures” for submitting warranties.

1.2 REFERENCE STANDARDS

A. EN 15804 - sustainability of construction works – environmental product declarations - core rules for the product category of construction products; 2012.

B. Greenscreen (list) - Greenscreen For Safer Chemicals list translator; clean production action; www.greenscreenchemicals.org.

C. Greenscreen (meth) - Greenscreen For Safer Chemicals method v1.2; clean production action; www.greenscreenchemicals.org.

D. ISO 14025 - Environmental Labels and Declarations -- type iii environmental declarations -- principles and procedures; 2006.

E. ISO 14040 - Environmental Management -- life cycle assessment -- principles and framework; 2006.

F. ISO 14044 - Environmental Management -- life cycle assessment -- requirements and guidelines; 2006.

G. ISO 21930 - Sustainability In Building Construction -- environmental declaration of building products; 2007.

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. Salvaged items or items reused from other projects are not considered new

products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.

3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, 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. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluation of Comparable Products: 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. [Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.]

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 or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:

1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."

F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.4 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- 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 equipment identification requirements.

1.5 COORDINATION

A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

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 that products are undamaged and properly protected.

C. Storage:

1. Provide a secure location and enclosure at Project site for storage of materials and equipment.
2. Store products to allow for inspection and measurement of quantity or counting of units.
3. Store materials in a manner that will not endanger Project structure.
4. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
5. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.

8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

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 standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to Owner.

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 in the Project Manual, 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 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS

A. As noted in specifications.

2.2 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by the contract documents.

B. Where all other criteria are met, contractor shall give preference to products that:

1. If used on interior, have lower emissions.
2. If wet-applied, have lower VOC content.
3. Have a published greenscreen chemical hazard analysis.

2.3 PRODUCT OPTIONS

A. Products specified by reference standards or by description only: Use any product meeting those standards or description.

B. Products specified by naming one or more manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products specified by naming one or more manufacturers with a provision for substitutions: Submit a request to the Architect (or Prime Consultant) via ACC web site for substitution for any manufacturer not named.

2.4 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver and place in location as directed; obtain receipt prior to final payment.

PART 3 - EXECUTION

3.1 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport and handle products in accordance with manufacturer's instructions.

E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.2 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

G. Comply with manufacturer's warranty conditions, if any.

H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

I. Prevent contact with material that may cause corrosion, discoloration, or staining.

J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 016000.

SECTION 016116 – VOLATILE ORGANIC COMPOUND (VOC) RESTRICTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides restrictions and requirements for Volatile Organic Compounds that will be furnished and installed. Products shall comply with the most stringent of federal, state or local requirements, or these specifications for general emissions and VOC content. Where reference standards are cited, the latest version shall be followed.

B. Related Requirements:

1. Section 013329 – Sustainable Design Requirements and Reporting
2. Section 015721 – Construction Indoor Air Quality Controls
3. Section 099000 – Painting and Coating

1.2 VOC-CONTENT RESTRICTED PRODUCTS

A. Provide products tested according to California Department of Public Health (CDPH) Standard Method v1.2–2017 (or latest applicable) and complies with the VOC limits in Table 4-1 of the method. VOC content not greater than required by the following.

1. Adhesives - (including Flooring Adhesives) and sealants: SCAQMD Rule 1168, October 6, 2017
2. Aerosol Adhesives: GreenSeal GS-36
3. Joint Sealants: SCAQMD 1168 Rule
4. Paints and Coatings: Each color, most stringent of the following:

    a. 40CFR 59, Subpart D
    b. SCAQMD, Rule 1113
    c. CARB 2007 (SCM)

1.3 ALL VOC-RESTRICTED PRODUCTS

A. Provide products having VOC content of types and volume not greater than those specified in State of California Department of Public Health (CDPH) for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

1.4 ADHESIVES AND SEALANTS

A. Compliance Levels (not to exceed the following):

a. Wood Glues: 30 g/L
b. Metal-to-Metal Adhesives: 30 g/L
c. Adhesives for Porous Materials (Except Wood): 50 g/L
d. Subfloor Adhesives: 50 g/L
e. Plastic Foam Adhesives: 50 g/L
f. Carpet Adhesives: 50 g/L
g. Carpet Pad Adhesives: 50 g/L
h. VCT and Asphalt Tile Adhesives: 50 g/L
i. Cove Base Adhesives: 50 g/L
j. Gypsum Board and Panel Adhesives: 50 g/L

k. Rubber Floor Adhesives: 60 g/L
l. Ceramic Tile Adhesives: 65 g/L
m. Multipurpose Construction Adhesives: 70 g/L
n. Fiberglass Adhesives: 80 g/L
o. Contact Adhesives: 80 g/L
p. Structural Glazing Adhesives: 100 g/L
q. Wood Flooring Adhesive: 100 g/L
r. Structural Wood Member Adhesive: 140 g/L
s. Single-ply Roof Membrane Adhesive: 250 g/L
t. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine-covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L
u. Top and Trim Adhesive: 250 g/L
v. Plastic Cement Welding Compounds: 250 g/L
w. ABS Welding Compounds: 325 g/L
x. CPVC Welding Compounds: 490 g/L
y. PVC Welding Compounds: 510 g/L
z. Adhesive Primer for Plastic: 550 g/L
aa. Sheet-Applied Rubber Lining Adhesive: 850 g/L
bb. Aerosol Adhesive, General-Purpose Mist Spray: 65% by weight
cc. Aerosol Adhesive, General-Purpose Mist Spray: 55% by weight
dd. Special-Purpose Aerosol Adhesive (All Types):70% by weight
ee. Other Adhesives: 250 g/L
ff. Architectural Sealants: 250 g/L
gg. Non membrane Roof Sealants: 300 g/L
hh. Single-Ply Roof Membrane Sealants: 450 g/L
ii. Other Sealants: 420 g/L
jj. Sealant Primers for Nonporous Substrates: 250 g/L
kk. Sealant Primers for Porous Substrates: 775 g/L
ll. Modified Bituminous Sealant Primers: 500 g/L
mm. Other Sealant Primers: 750 g/L

1.5 PAINTINGS AND COATINGS

A. Compliance Levels (not to exceed the following):

a. Flat Paints and Coatings: VOC 50 g/L
b. Non-Flat Paints and Coatings: VOC 100 g/L or 50 g/L per SCAQMD
c. Nonflat – High Gloss Paints and Coatings: VOC 150 g/L
d. Concrete/Masonry Sealers: 100 g/L
e. Dry-Fog Coatings: VOC 150 g/L
f. Faux Finishing Coatings: VOC 350 g/L
g. Floor Coatings: VOC 100 g/L
h. High-Temperature Coatings: VOC 420 g/L
i. Industrial Maintenance Coatings 250 g/L
j. Pre-Treatment Wash Primers: VOC 420 g/L
k. Primers, Sealers and Undercoaters: VOC 100 g/L or 50 g/L per SCAQMD
l. Rust preventative: 250 g/L or 100 g/L per SCAQMD
m. Shellacs, Clear: VOC 730 g/L
n. Shellacs, Pigmented: VOC 550 g/L
o. Specialty Primers, Sealers and Undercoaters: VOC 100 g/L
p. Stains: VOC 250 g/L
q. Traffic Marking Coatings: VOC 100 g/L
r. Waterproofing Concrete/Masonry Sealers: N/A (See Concrete/Masonry Sealers)
s. Clear Wood Finishes, Varnishes: VOC 350 g/L
t. Clear Wood, Lacquers: VOC 550 g/L

u. Zinc-Rich Industrial Maintenance Primers: VOC 340 g/L

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 016116

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SECTION 017329 – CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Examination, preparation, and general installation procedures.
2. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.
3. Cutting and patching.
4. Protection of installed work.
5. Starting of systems and equipment.
6. Closeout procedures, including contractor's correction.
7. Punch list, except payment procedures.

B. Related Requirements:

1. Section 013100 - Project Management and Coordination.
2. Section 015000 - Temporary Facilities and Controls
3. Section 017419 - Construction Waste Management and Disposal: additional procedures for trash/waste removal, recycling, salvage, and reuse.
4. Section 017423 - Final Cleaning.
5. Section 017700 - Closeout Procedures.
6. Section 017823 - Operations and Maintenance Data.
7. Section 017900 – Demonstration and Training.
8. Section 078413 – Penetration Firestopping.

1.2 REFERENCE STANDARDS

A. NFP 241 - standard for safeguarding construction, alteration, and demolition operations; 2013.

1.3 SUBMITTALS – NOT USED

1.4 QUALIFICATIONS

A. For demolition work, employ a firm specializing in the type of work required.

1.5 PROJECT CONDITIONS

A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

B. Dust control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property. Provide construction grade air filters at all AHUs in construction zone.

1. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Tenant.

C. Noise control: Provide methods, means, and facilities to minimize noise produced by construction operations.

1. Excessively noisy tools and operations are to be limited to times allowed by the jurisdiction and are to be coordinated so as to have minimal audible impact to others within the immediate area and adjacent areas.

a. Jackhammers are an example of excessive noise.
b. Coordinate times for operations which may produce excessive noise with Owner and neighbors when possible.

1.6 COORDINATION

A. Coordinate scheduling, submittals, and work of the various sections of the project manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Notify affected utility companies and comply with their requirements.

C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of work of separate sections.

G. After Tenant occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with contract documents, to minimize disruption of Tenant’s activities.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

A. New materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and quality of existing products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product substitution: For any proposed change in materials, submit request for substitution described in section 016000 – Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION AND LAYING OUT THE WORK

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Promptly notify Architect of any discrepancies discovered.

C. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

D. Examine and verify specific conditions described in individual specification sections.

E. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or mis fabrication.

F. Verify that utility services are available, of the correct characteristics, and in the correct locations.

G. Prior to cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated. Locate and lay out by instrumentation and similar appropriate means. Periodically verify layout by same means.

C. Maintain a complete and accurate log (minimum weekly reports) of control and survey work as it progresses.

D. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

E. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

F. Make neat transitions between different surfaces, maintaining texture and appearance.

G. Transformation room and ambient food storage.

1. All cracks in floors, walls and ceilings shall be caulked and sealed.

H. Transformation room.

1. Shall slope a minimum of 1:50 minimum to the floor drain.
2. Food grade shielding must be provided for all light fixtures.

a. Bulbs with plastic coating.
b. Capped plastic tubing on fluorescent fixtures.
c. Fully covered or shielded light fixtures.

3. Wireless access points are to be exterior rated or have a protective waterproof cover.

3.4 ALTERATIONS

A. Drawings showing existing construction and utilities are based on field observation and existing record documents only.

1. Verify that construction and utility arrangements are as shown.
2. Report discrepancies to architect before disturbing existing installation.
3. Beginning of alterations work constitutes acceptance of existing conditions.

B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.

C. Remove existing work as indicated and as required to accomplish new work.

1. Remove items indicated on drawings.
2. Relocate items indicated on drawings.
3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary, for successful application of new finish.
4. Where new surface finishes are not specified or indicated,
5. Patch holes and damaged surfaces to match adjacent
6. Finished surfaces as closely as possible.

D. Services (including but not limited to HVAC, plumbing, fire protection, electrical, and telecommunications): remove, relocate, and extend existing systems to accommodate new construction.

1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
2. Where existing systems or equipment are not active and contract documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.

a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
b. Provide temporary connections as required to maintain existing systems in service.

4. Verify that abandoned services serve only abandoned facilities.
5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.

E. Protect existing work to remain.

1. Prevent movement of structure; provide shoring and bracing if necessary.
2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
3. Repair adjacent construction and finishes damaged during removal work.

F. Adapt existing work to fit new work: make as neat and smooth transition as possible.

1. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to architect.
2. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
3. Where a change of plane of 1/4 inch or more occurs in existing work, submit recommendation for providing a smooth transition for architect review and request instructions.

G. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.

H. Refinish existing surfaces as indicated:

1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.

I. Clean existing systems and equipment.

J. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.

K. Do not begin new construction in alterations areas before demolition is complete.

L. Comply with all other applicable requirements of this section.

3.5 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. See alterations article above for additional requirements.

C. Perform whatever cutting and patching is necessary to:

1. Complete the work.
2. Fit products together to integrate with other work.
3. Provide openings for penetration of mechanical, electrical, and other services.

4. Match work that has been cut to adjacent work.
5. Repair areas adjacent to cuts to required condition.
6. Repair new work damaged by subsequent work.
7. Remove samples of installed work for testing when requested.
8. Remove and replace defective and non-conforming work.

D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

E. Employ original installer, or qualified installer, to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

G. Restore work with new products in accordance with requirements of contract documents.

H. Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.

J. Patching:

1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
2. Match color, texture, and appearance.
3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.6 PROTECTION OF INSTALLED WORK - SEE SECTION 017600 FOR ADDITIONAL REQUIREMENTS

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Protect traffic from landscape areas.

H. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

3.7 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

F. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

G. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.8 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

END OF SECTION 017300

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SECTION 017400 - PROGRESS CLEANING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. These requirements supplement General Conditions.

1. See General Conditions and individual specification sections for each individual contractors' specific cleaning requirements.
2. General Conditions to take precedence if requirements differ.

B. Each contractor: execute cleaning, during progress of the work and at completion of the work, as required by contract documents.

C. Related Requirements:

1. Section 016116 “Volatile Organic Compound (VOC) Restrictions
2. Section 017423 – Final Cleaning
3. Section 024119 – “Selective Demolition.”
4. Section 039300 – “Concrete Rehabilitation” for concrete rehabilitation and repairs.
5. Cleaning for specific products or work: Specification section for the work.

1.2 CLEANING AND DISPOSAL REQUIREMENTS

A. Standards: Maintain project in accord with the following safety and insurance standards:

1. Applicable federal and state requirements.
2. National Fire Protection Association.

B. Hazards control: Each contractor shall comply with the following requirements:

1. Store volatile wastes in covered metal containers and remove from premises daily.
2. Prevent accumulation of wastes, which create hazardous conditions.
3. Provide adequate ventilation during use of volatile or noxious substances.

C. Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.

1. Do not burn or bury rubbish and waste materials on project site.
2. Do not dispose of volatile wastes such as mineral spirits, oil or paint thinner in storm or sanitary sewers.
3. Do not dispose of waste into streams or waterways.
4. Wet down dry materials and rubbish to prevent dust.

D. Clean streets, highways, and private properties of all mud, earth, rubbish, rocks, refuse or other debris of any kind resulting from such work or related transportation to and from the work site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Select and use cleaning materials and equipment with care to avoid scratching, marring, defacing, staining or discoloring surfaces cleaned.

B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

1. Use cleaning products that meet Green Seal GS-37, or if GS-37 is not applicable, use products that comply with the California code of regulations maximum allowable VOC levels, or maximum allowable VOC levels stated in section 016116, whichever is most restrictive.

C. Use cleaning materials only on surfaces recommended by the cleaning material manufacturer.

PART 3 - EXECUTION

3.1 PROGRESS CLEANING

A. Clean project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

B. General Contractor to coordinate waste requirements for all sub contractors.

1. Provide, maintain and empty 55 gallon metal and dumpster type containers for collection of waste materials, debris and rubbish. GC is to coordinate the location of dumpsters with Tenant site operations during project kickoff. These containers will be utilized by all contractors and their subcontractors.

a. Provide containers with adequate capacity to accommodate anticipated needs. If containers do not have adequate capacity, increase intervals of waste removal or capacity of containers until adequate capacity is provided.

2. At reasonable intervals during progress of work, but in no case less than once a week, dispose of waste materials, debris and rubbish.
3. Direct special attention to:

a. Provide non-staining layout lines and other markings on masonry and concrete. Use chalk lines wherever possible and remove when no longer needed.
b. Remove all stains from concrete surfaces, including floors.
c. Shop marks shall not appear on exposed surfaces of any item.
d. Remove concrete, mortar and paint spatters.
e. Clean both brick and concrete unit masonry.
f. Protect aluminum frames during construction and thoroughly clean upon completion of the installation.

4. Clean interior surfaces before start of finish painting and continue cleaning on an as-needed basis until painting is finished.
5. Vacuum interior building areas where work is performed prior to painting and other finish work. Continue vacuum cleaning on an as needed basis until building is ready for occupancy.

C. Heating/piping/temperature control and ventilation and ductwork contractor: coordinate and protect interior of ductwork during construction from accumulation of dirt, dust or debris.

D. All contractors

1. Site: maintain project site free of waste materials and debris.
2. Work areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the work.
3. Remove liquid spills promptly.
4. Where dust would impair proper execution of the work, broom-clean or vacuum the entire work area, as appropriate.
5. 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.
6. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly coated surfaces.
7. Handle materials in a controlled manner with as few handlings as possible; do not drop or throw materials from heights.
8. Clean trash from all chases and concealed spaces before final closure.

END OF SECTION 017400

SECTION 017419 – CONSTRUCTION WASTE MANAGEMENT (CWM) AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides the requirements for onsite waste management and disposal.

B. Related Requirements:
   1. Section 013329 – Sustainable Design Requirements and Reporting

1.2 WASTE MANAGEMENT PLAN

A. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

B. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

C. Contractor shall retain periodic waste disposal reports/records; all landfill disposal, incineration, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.

D. General Contractor to develop a Construction Waste Management Plan (CWMP) to be submitted within 30 days of NTP to the Tenant. The project shall generate the least amount of waste possible during demolition and construction. The project shall target at minimum 80% landfill diversion rate for all non-hazardous construction demolition and land-clearing waste.

E. If any waste materials encountered during the demolition or construction phase are hazardous materials, they are to be handled and removed in accordance with local, state, and federal laws and requirements concerning hazardous waste.

F. At a minimum, the Construction Waste Management Plan (CWMP) should outline responsible purchasing and fabrication methods to minimize waste generation; major materials waste streams and diversion method (e.g. reuse, salvage, or recycle); and site management protocols to adequately separate, stage and dispose of materials.

G. Methods of trash / waste disposal that are not acceptable include:
   1. Incineration, either on or off the project site.
   2. Burying materials on the project site.
   3. Illegal dumping or burying materials off the property, public, or private.

H. The following list of required materials, at a minimum, must be included for salvaging/recycling:
   1. Cardboard
   2. Clean dimensional wood
   3. Beverage and food containers
   4. Paper
   5. Concrete
   6. Concrete Masonry Units (CMUs)
   7. Asphalt: Include the approximate weight of the asphalt paving to be crushed and utilized as granulated fill from the existing paving as a component of waste material diverted from the landfill.

8. Ferrous and non-ferrous metals (banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze).
9. Stretch and shrink wrap
10. Gypsum wallboard
11. Paint containers and other clean, empty plastic containers.

I. As part of the Waste Management Plan provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project. Provide final Waste Management Report with a summary of all materials diversion rates, Waste Disposal Reports and associated tipping receipts or takeoffs to Tenant. Use template “Construction Waste Diversion and Recycling Rate Calculator” provided by Tenant for completion of monthly reports: https://docs.b360.autodesk.com/shares/1526af9a-d2c8-45ce-9f08-36ce6ba0cca1

J. Dumpster pulls for Material Handling Equipment must be coordinated with Tenant Construction Manager.

K. Regulatory requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

L. Outdoor dumpsters will be covered at all times when not being actively loaded or unloaded to prevent contamination of storm water runoff. Equipment and materials stored outside with any potential to impact storm water runoff shall be covered in such a way as to prevent this possibility or stored indoors

M. The project shall not impact the status of the Tenant site under applicable environmental regulations as a non-exposure site. No process or materials used as part of the project shall impact water released to the storm sewers unless the proper permits have been obtained

1.3 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and demolition waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.4 REQUIRED MATERIALS FOR SALVAGING / RECYCLING

A. The following list of required materials, at a minimum, must be included for salvaging/recycling:
1. Cardboard
2. Clean dimensional wood
3. Beverage and food containers
4. Paper
5. Concrete
6. Concrete Masonry Units (CMUs)
7. Asphalt: Include the approximate weight of the asphalt paving to be crushed and utilized as granulated fill from the existing paving as a component of waste material diverted from the landfill.
8. Ferrous and non-ferrous metals (banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze)
9. Stretch and shrink wrap
10. Gypsum wallboard
11. Paint containers and other clean, empty plastic containers

1.5 RESPONSIBLE ON SITE PERSONNEL

A. As part of Waste Management Plan, provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

1.6 REPORTS

A. Provide final Waste Management Report with a summary of all materials diversion rates, Waste Disposal Reports and associated tipping receipts or takeoffs to Tenant. General Contractor shall use the LEED v4.1 Construction and Demolition Waste Management Calculator.

B. https://www.usgbc.org/resources/leed-v41-construction-and-demolition-waste-management-calculator

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the waste management plan.

B. Communication: Distribute copies of the waste management plan to job site foreman, each subcontractor, owner, and architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Hazardous wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

E. Reuse of materials on-site: Set aside, sort, and protect separated products in preparation for reuse.

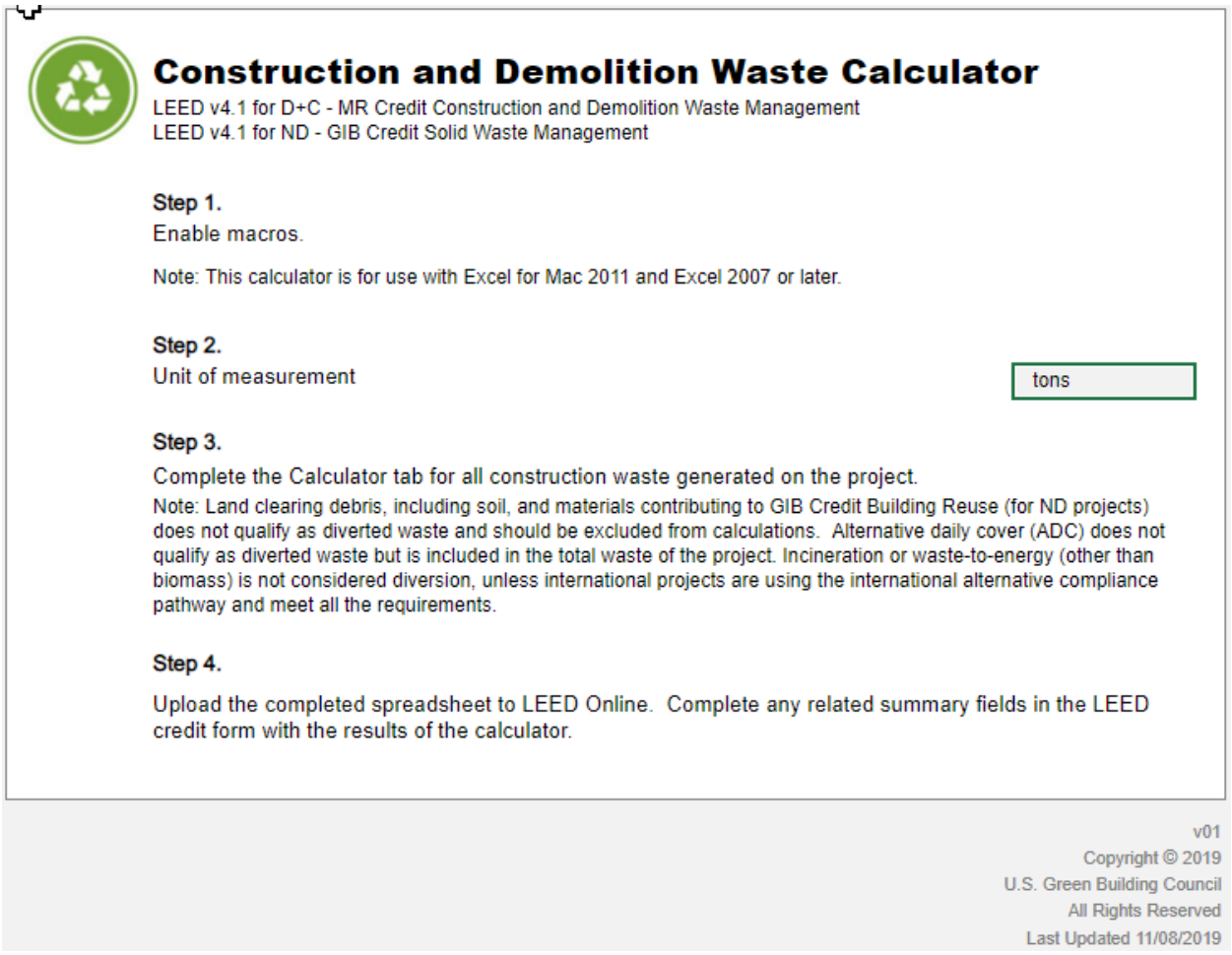
F. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION 017419

Appendix A:

Example LEED v4.1 Construction and Demolition Waste Management Calculator
As posted: January 3, 2022

Instructions:



Construction and Demolition Waste Calculator

LEED v4.1 for D+C - MR Credit Construction and Demolition Waste Management
LEED v4.1 for ND - GIB Credit Solid Waste Management

Step 1.
Enable macros.

Note: This calculator is for use with Excel for Mac 2011 and Excel 2007 or later.

Step 2.
Unit of measurement: tons

Step 3.
Complete the Calculator tab for all construction waste generated on the project.
Note: Land clearing debris, including soil, and materials contributing to GIB Credit Building Reuse (for ND projects) does not qualify as diverted waste and should be excluded from calculations. Alternative daily cover (ADC) does not qualify as diverted waste but is included in the total waste of the project. Incineration or waste-to-energy (other than biomass) is not considered diversion, unless international projects are using the international alternative compliance pathway and meet all the requirements.

Step 4.
Upload the completed spreadsheet to LEED Online. Complete any related summary fields in the LEED credit form with the results of the calculator.

v01
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Last Updated 11/08/2019

Calculator:

Calculator

Material Description	Material Type	Material Stream	Total amount of materials generated (tons)	Commingled Recycling: Average recycling rate of the sorting facility used during the project active timeline. Include ADC in the recycling rate	Commingled Recycling: Average recycling rate of the sorting facilty NOT including ADC (%)	Commingled Recycling: Certified Commingled Recycling Facility?	Diverted Materials (tons)	Percent Diverted (%)	Total Waste Generated (tons)
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
							0.00	0.00%	0.00
Total construction waste generated (tons)									0.00
Total diverted construction waste (tons)									0.00
Total amount of materials generated for the project (tons)									0.00
For D+C projects	Total number of diverted material streams								0
	Additional material stream if all commingled materials are processed by certified recycling facilities								0
For ND projects	Total diverted asphalt, brick (masonry), and concrete (ABC) waste (tons)								0.00

Summary D+C:

Summary for Design and Construction Rating Systems

Note: All information on this tab is READ-ONLY. To edit, see the previous tab.

Total amount of materials generated for the project (tons)	0.00
Total construction waste diverted (tons)	0.00
Percentage of construction waste diverted from landfill (%)	0.00%
Number of material streams diverted	0

Option 1 Credit Pathways:

Path 1. Divert 50% and Two Material Streams (1 point)

Path 2. Divert 50% using Certified Commingled Recycling Facility (1 Point)

Path 3. Divert 75% and Three Material Streams (2 points)

Path 4. Divert 75% using Certified Commingled Recycling Facility and One More Material Stream (2 points)

For Option 2 Credit Achievement: fill out this calculator and include additional information necessary to document compliance following instructions on the LEED form.

Summary ND:

Summary for Neighborhood Development Rating Systems

Note: All information on this tab is READ-ONLY. To edit, see the previous tab.

Total construction waste (tons)	0.00
Total construction waste diverted (tons)	0.00
Percentage of construction waste diverted from landfill (%)	0.00%

For projects with asphalt, brick, and concrete waste

Total diverted asphalt, brick, and concrete (ABC) waste (tons)	0.00
Total construction waste diverted (tons)	0.00
ABC diverted waste as a percentage of total diverted waste (%)	0.00%

Appendix B:

Example Construction and Demolition Waste Management Plan
As posted: January 12, 2022

Construction and Demolition Waste Management Plan

Waste Diversion Goals

- **Divert at least 80% by {weight or volume – GC to indicate} of the total construction and demolition (C&D) waste materials generated onsite.**
- **Acceptable waste stream diversion methods include reuse, recycle, and salvage.**
- **Methods of trash/waste disposal that are not acceptable are:**
    - **Incineration, either on- or off-site.**
    - **Burying materials on the project site.**
    - **Illegal dumping or burying materials off the property, public or private.**

Targeted Materials

- **The following list of required materials, at a minimum, must be included for salvaging/recycling:**
    - **Cardboard**
    - **Clean dimensional wood**
    - **Beverage and food containers**
    - **Paper**
    - **Concrete**
    - **Concrete Masonry Units (CMUs)**
    - **Asphalt: Include the approximate weight of the asphalt paving to be crushed and utilized as granulated fill from the existing paving as a component of waste material diverted from the landfill.**
    - **Ferrous and non-ferrous metals (banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze)**
    - **Stretch and shrink wrap**
    - **Gypsum wallboard**
    - **Paint containers and other clean, empty plastic containers**
- **If any waste materials encountered during the demolition or construction phase are hazardous materials, they are found to be handled and removed in accordance with local, state, and federal laws and requirements concerning hazardous waste.**

Separation Procedures

- **Project team shall determine if comingled recycling will be pursued. For comingled recycling, the General Contractor xxx shall coordinate with the waste vendor yyy to provide a single recycling container. The waste vendor yyy shall separate the waste offsite and provide a monthly receipt with weight/volume of different materials being diverted.**
- **Alternatively, separate containers labeled for each material shall be provided for materials to be sorted onsite. The waste vendor yyy shall provide a monthly receipt with {weight/volume} of different materials being diverted.**

Communication Plan

- **An onsite, preconstruction meeting will be conducted with subcontractors to review the project's waste diversion goals and processes. Attendance is mandatory for the subcontractor's key field personnel. The purpose of the meeting is to reinforce participants' commitments to the project goals and requirements.**

- **Waste prevention and recycling activities will be discussed during each job meeting. Strategies for course correction will be discussed and implemented as needed if the project is not meeting diversion goals.**
- **Each contractor and subcontractor will be given a copy of this CWM plan, and will be provided with instruction in appropriate separation and handling procedures. A tour of the recycling and waste management areas will also be conducted. Each subcontractor is expected to ensure his/her crews understand and comply with this plan.**
- **Bilingual signage must be affixed to all dumpsters.**
- **Regular updates will be posted showing the progress to-date for achieving the project's waste recycling goals.**
- **General Contractor to designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan. Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.**

Contamination Prevention Measures

- **A specific area will be designated onsite to facilitate separation of materials for potential recycling, salvage, reuse, and return.**
- **Small roll-off sorting containers will be conveniently located in various work areas. The containers will be well-marked and kept clean to prevent contamination.**
- **Recycling and waste containers will be labeled in English and Spanish, with acceptable/unacceptable materials posted. Signage can show a representative picture of the materials to be recycled.**
- **The contents of the small sorting bins will be periodically consolidated in the appropriate dumpsters.**
- **Sufficient containers for non-recyclable materials will be provided and located next to recycling containers, with clear signage.**
- **Containers will be securely covered when not supervised. Precautions will be taken to deter any contamination by the public.**
- **Hazardous wastes will be separated and stored in a specific area onsite, and will be disposed of in accordance with local regulations. They will be tracked separately and not included in the project's total waste.**

Expected Waste Streams & Disposal Procedures

- **The following waste materials are expected for this project and should be included in the diversion rate calculation. The table below indicates the disposal method, the appropriate handling procedure, and the anticipated quantity for each material.**

Waste Stream	Jobsite Disposal Method	Handling Procedure	Anticipated Quantity
SAMPLE Concrete: Including CMU	Recycle "Clean Concrete Only" container	Place excess concrete, free of waste, in appropriate dumpster	200 tons
SAMPLE Asphalt	Recycle	Remove asphalt via loader and place in truck to be hauled from site	25 tons
SAMPLE Scrap metal: Including rebar, steel studs, metal flashing, scrap	Recycle "Metal Only" container	Place acceptable scrap metal in appropriate dumpster	50 tons

hardware, embeds, hollow metal and aluminum frames, piping			
Wood products: Untreated wood, plywood, OSB, particle board, clean dimensional wood, wood pallets	Recycle "Wood Only" container	Place wood, free of waste materials, that is unusable for construction in appropriate dumpster Place painted/treated wood in "Landfill Only" dumpster	75 tons
Masonry products: Including face bricks, hollow bricks	Reuse / Return	Stockpile bricks that are unusable for construction for return to the manufacturer	25 tons
Cardboard	Recycle "Cardboard Only" container	Clean cardboard will be broken down and placed in appropriate dumpster Unless a diversion method or outlet is identified, all packing materials must be removed and disposed of properly in the "Landfill Only" container	10 tons
Carpet tiles	Recycle "Carpet Only" container	Place carpet tile scraps in appropriate dumpster for pick up by carpet recycler	0.25 tons
Drywall	Recycle "Drywall Only" container	Place drywall waste that can't be used for construction in appropriate dumpster	15 tons
Aluminum and plastic containers, mixed paper	Recycle "Recycling" tote	Place in general recycling tote	1 ton
All other non-recyclable C&D waste	Landfill "Landfill Only" container	Place all other waste that cannot be recycled in "Landfill Only" dumpsters	500 tons

Additional Waste Materials

- **The following waste materials are not included in the diversion rate calculation but must be tracked and reported separately in the project's construction waste report.**

Waste Stream	Description/Information
Land-clearing debris	Land-clearing debris materials are natural (e.g., rock, soil, vegetation) and should be diverted from the landfill if possible.

Hazardous materials	Hazardous materials will be separated and stored in a specific area onsite, and will be disposed of in accordance with local regulations.

Recycling Facilities and Processing Method

- The recycling facility and processing method for each anticipated diverted waste stream that is included in the diversion rate calculation is summarized below.

Waste Stream	Destination	Processing Information
Concrete	ABC Recycling Co	Recycled into various uses, depending on market (e.g., into base product for buildings and roads)
Asphalt	ABC Recycling Co	Reprocessed into new asphalt
Scrap metal	XYZ Recycling	Recycled in the scrap metal market
Wood products	XYZ Recycling	Recycled into mulch
Masonry products	Manufacturer	Manufacturer take-back for reuse or recycling into other products
Cardboard	XYZ Recycling	Recycled into new cardboard containers
Carpet tiles	Manufacturer	Manufacturer take-back for recycling
Drywall	XYZ Recycling	Recycled into soil amendment product
Aluminum and plastic containers, mixed paper	XYZ Recycling	Recycled into new products

Tracking Procedures and Records

- All the construction and demolition waste leaving the site will be tracked.
- Monthly waste hauler reports will be used for documentation.
- Estimated {weight or volume} of materials that are reused on site or salvaged for reuse on other projects by subcontractors or vendors will be recorded.
- Receipts will be retained and {weight or volume} will be estimated for materials donated to charities, reuse retailers, or other recipients that can verify and track incoming and outgoing materials.

Construction Waste Report

- A final report on all the waste for the project will be produced that includes the following information:

- **Total C&D waste produced by the project.**
- **Types of waste material and quantity of each material.**
- **Total waste diverted and diversion rate**
  - **Diversion rate = (Total C&D waste diverted from the landfill / Total C&D waste produced by the project) x100**
- **Land-clearing debris or hazardous waste will not be included in the diversion rate calculation but the disposition of these materials will be separately.**
- **Construction materials to be processed into ADC will be included in the Total C&D waste produced by the project in the diversion rate calculation.**

- **A final waste management report with a summary of all materials diversion rates shall be submitted to Owner. General Contractor shall use the LEED v4.1 Construction and Demolition Waste Management Calculator. (https://www.usgbc.org/resources/leed-v41-construction-and-demolition-waste-management-calculator)**

SECTION 017423 - FINAL CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Coordinating contractor: Provide all final cleaning including for the work of assigned contractors.

a. At completion of work remove all waste, debris, rubbish, tools, equipment, machinery and surplus materials. Clean all sight exposed surfaces; leave work clean and ready for occupancy.

B. Related Requirements:

1. Section 016116 “Volatile Organic Compound (VOC) Restrictions
2. Section 017400 - Progress Cleaning.

1.2 SAFETY REQUIREMENTS

A. Comply with the requirements of authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 CLEANING 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.

B. Cleaning agents shall meet green seal GS-37 standards.

C. Floor cleaners shall comply with the California code of regulations maximum allowable VOC content.

D. Disposable paper products, supplies and trash bags shall meet the minimum requirements of the us environmental protection agency's comprehensive procurement guidelines.

E. If the green seal GS-37 standard is not applicable, use products that comply with the California code of regulations maximum allowable VOC levels, or maximum allowable VOC levels stated in section 016116, whichever is more restrictive.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Provide final cleaning. Do not conflict with related project sections. Resolve with ae should any conflicts arise. 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.

C. Complete the following cleaning operations before requesting inspection for certification of substantial completion for entire project or for a portion of project:

1. 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.
2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
3. Remove tools, construction equipment, machinery, and surplus material from project site.
4. Remove snow and ice to provide safe access to building.
5. 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.
6. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
7. Sweep concrete floors broom clean in unoccupied spaces.
8. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
9. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
10. Remove labels that are not permanent.
11. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration. A. Do not paint over "ul" and similar labels, including mechanical and electrical nameplates.
12. Remove grease, dust, dirt, stains, labels, fingerprints, protection and other foreign materials from sight- exposed interior and exterior finished surfaces; polish surfaces so designated to specified finish. A. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces to ensure performance.
13. Contractor vacuum clean and mop all surfaces of pedestal floors and supports, including entire area beneath pedestal floors.
14. Ventilating contractor shall replace air handling (conditioning) filters if units were operated during construction. Clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
15. Ventilating contractor shall vacuum clean ducts, blowers and coils.
16. Each contractor shall maintain finally cleaned areas until project, or designated portion thereof, is accepted by the owner.
17. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
18. Replace parts subject to unusual operating conditions.
19. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
20. First subparagraph below describes a major work item that may be disruptive to closeout procedures. Clean ducts, blowers, and coils if units were operated without filters during construction.
21. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy

starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

22. Leave project clean and ready for occupancy.
23. Pest control: Engage an experienced, licensed exterminator to make a final inspection and rid project of rodents, insects, and other pests. Prepare and submit a report indicating compliance.
24. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from project site and dispose of lawfully.

END OF SECTION 017423

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SECTION 017600 - PROTECTING INSTALLED CONSTRUCTION

PART 1 - GENERAL

1.1 PROTECTION OF ALL INSTALLED CONSTRUCTION

A. Any component / system that is damaged, including but not limited to accidents or misuse resulting in scratches, dents, abrasions etc., shall be repaired back to “like new condition”, otherwise the same equipment shall be replaced with new equipment prior to “final acceptance” to the satisfaction of the project manager. This applies to all installed construction, including general, mechanical, and electrical devices, equipment and systems, regardless of acceptance for use during construction.

B. The contractor shall only use permanent equipment as specified in the contract documents. Specific requests to use permanent equipment other than what is specified in the contract documents must first be approved by the project manager, A/E and commissioning authority prior to such use. This includes the use of devices, equipment, and systems, such as elevators or HVAC equipment, during any phase of construction prior to “final acceptance.”

C. During the construction process, each contractor shall provide a written plan outlining conformance with all contract sections and shall ensure that all installed devices, equipment and systems are not exposed to construction environments that are likely to hinder their proper operation/performance or shorten their useful life regardless of desire by contractor for use prior to “final acceptance.”

D. All equipment warranties shall be adjusted and / or extended so as to not impact the normal minimum expected warranty duration as expressed or implied within this project in accordance with the base bid requirements and without additional cost to the project.

E. Protect all components containing fluid(s) from freezing. Ensure all related safeties and necessary controls are active and functioning. Verify with project manager, A/E and commissioning authority prior to use. This will not constitute “final acceptance” of components or systems.

F. Under no circumstance shall any system in whole or part be allowed to operate beyond the design parameters of this project or the respective manufacturer's limits.

1.2 USE OF PERMANENT AIR HANDLING UNIT (AHU) AND DISTRIBUTION SYSTEMS FOR CONSTRUCTION PURPOSES

A. The use of permanently installed AHUs and associated distribution systems for temporary heating and cooling during construction shall only be permitted as specified in the contract documents. Specific requests to use permanently installed HVAC equipment other than what is specified in the contract documents must first be approved by the project manager, A/E and commissioning authority prior to such use. Requests shall be considered only after a written plan for temporary use has been provided clarifying satisfactory implementation of the requirements of this section. Requests do not constitute automatic approval for use.

B. Coordinate work with related air handling equipment, duct and duct accessory sections.

C. All work on the AHUs shall be permanent, not temporary. This includes unit ductwork and insulation, hot water and chilled water pumps, piping and insulation, unit condensate drains if used for cooling, electrical components and controls.

D. At no additional cost to the project or Tenant, minimum basic requirements that shall be met if permanent equipment is permitted to be used include:

   1. Fans and related system components shall not run in such a manner as to allow fans to be in surge or unstable operation nor run within 80% of maximum rpm.
   2. Any meters, such as steam or chilled water, shall be operative, installed, calibrated and functioning prior to use. If necessary, a temporary meter shall be installed which meets the same reliability and accuracy requirements as the permanent meter specified in the contract documents.

E. Controls shall ensure safe operation without risk to the equipment or building. Freeze stats, static pressure safety switches, control dampers, etc. Shall be in operation and successfully functionally tested. A means to send out an alarm in case of unit failure shall be in place.

F. Perform all specified and manufacturer's start up procedures on all equipment being used, including VFDs. Provide verified results, data, reports, checklists to the Tenant's representative.

G. A written plan shall be implemented to monitor the systems and ensure adequate changing of filters. This plan shall include in writing the contractor or subcontractor who is responsible to monitor and maintain the systems in operation, ensure that the plan is adhered to and respond when there is a failure. It is recommended that this be the ventilation contractor.

H. Air distribution systems shall be aggressively protected from dust during the construction process to ensure that no contamination of the duct system occurs. If air handling equipment is operated during the construction process for any reason (e.g. to provide temporary heat) for any length of time, special provisions shall be made to provide adequate filtration to protect all air handling equipment, distribution and return ductwork from exposure to dust, with filters being changed on a regular and frequent basis.

I. All return ductwork shall be disconnected from the respective supply ahu and capped to prevent contamination. Filters of sufficient ASHRAE spot efficiency shall be used at all ahu entrance(s) and normal filter sections in air handlers during construction use to prevent pass-through of construction dust 3 microns and larger in size even though the project's filter classification as of occupancy may be less.

J. Where it is physically impossible to disconnect and mechanically cap respective return ductwork, minimum efficiency filters of a MERV 13 or higher rating shall be installed at all return ducting entrances (or openings to plenum areas) and normal filter sections in air handlers and maintained throughout the construction period to prevent pass-through of construction dust 3 microns and larger in size. Reauthorization from the project manager, A/E and commissioning authority Tenant is required before proceeding.

K. Pipe flushing shall be completed, and report validated with appropriate chemical testing.

L. All permanent filters shall be installed in the ahu and maintained throughout use. All filtration shall be at the expense of the contractor.

M. Manufacturer warranty issues shall be resolved. Warranty extensions may be necessary.

N. Equipment used for temporary heating/cooling shall be in "like new" condition when turned over.

O. Comply with SMACNA IAQ guidelines for occupied buildings under construction.

P. The contractor is responsible for meeting the more restrictive indoor air quality conditions during construction as stated in the contract documents or throughout the NADCA standards and procedures as referenced within the April 8, 2002 edition or newer “NADCA general specifications for the cleaning of commercial heating, ventilating and air conditioning systems”. It is the responsibility of the contractor to perform cleaning using these NADCA approved cleaning equipment and procedures of all internal duct paths and ahu(s) just prior to final inspection / commissioning for consideration of final acceptance.

1.3 USE OF EXISTING ELEVATORS FOR CONSTRUCTION PURPOSES (NO ELEVATOR CONTRACTOR IS CONTRACTED FOR THE PROJECT)

A. Unless expressly permitted by means of approval with the landlord or building owner, the use of an existing elevator during construction shall be strictly prohibited.

1.4 FINISHES AND FURNISHINGS

A. Each contractor shall ensure that all installed finishes and furnishings are not exposed to construction environments that are likely to mar their appearance or shorten their useful life. For example, carpet and other floor finish surfaces shall not be installed at a stage in the project, which will result in them being subjected to excessive soiling, spotting, staining, scratching, abrasion, or wetting. Contractor or sub-contractors shall not use any installed furniture item as a bench, ladder or support for work they may be completing in any existing space. If such furnishings impede or block assigned work, contractor shall notify owner for adjustment or removal of said furnishings.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION: NOT USED

END OF SECTION 017600

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SECTION 017700 - 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. Punch List.
4. Turnover Package Baseline Requirements.
5. Operation and Maintenance Manual Documentation.
6. Lien Waivers.
7. Electronic Media Sets.
8. Training Videos.
9. EAM Data.
10. Archiving and Retention.
11. Warranties.
12. Final cleaning.

B. Related Requirements:

1. Section 017823 – “Operation and Maintenance Data”
2. Section 017839 – “Project Record Documents”
3. Section 017900 – “Demonstration and Training”
4. Divisions 02 through 33 sections for specific closeout and special cleaning requirements for the work in those sections.

1.3 SUBSTANTIAL COMPLETION PROCEDURES

A. Preliminary procedures: Before requesting inspection for determining date of substantial completion, complete the following. List items below that are incomplete with request.

1. Review Tenant Pre-Punch Walk Checklist on ACC and prepare a list of items to be completed and corrected, the value of items on the list, and reasons why the work is not completed at date of anticipated Substantial Completion.
2. Coordinate Punch Walk with A/E firms and Tenant representative.

    a. General contractor to send out an electronic calendar notification / invitation for punch walk to all stakeholders a minimum of two weeks in advance of the request punch walk date.
    b. Review items identified on Punch Walk Checklist to be completed.
    c. Provide substantiation via website of completion via photographs, additional site observations, or Tenant construction manager approval to clear any outstanding items.

d. Maintain report on website regarding the status of all outstanding punch walk items, and their resolutions.

3. Advise Tenant of pending insurance changeover requirements.
4. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents via ACC and/or CBRE closeout procedures, or other approved method.
5. Obtain and submit releases permitting Tenant unrestricted use of the work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
6. Prepare and submit project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
7. Deliver tools, spare parts, extra materials, and similar items to location designated by Tenant. Label with manufacturer's name and model number where applicable.
8. Deliver and label all temporary and permanent keys for locks to Tenant. Advise Tenant's personnel of changeover in security provisions.
9. Complete startup testing of systems.
10. Submit test/adjust/balance records.
11. Terminate and remove temporary facilities from project site along with mockups, construction tools, and similar elements.
12. Advise Tenant of changeover in heat and other utilities.
13. Submit changeover information related to Tenant's occupancy, use, operation, and maintenance.
14. Complete final cleaning requirements, including touchup painting.
15. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: the General Contractor is to coordinate with the building owner and the building tenant for a punch walk with the design team to determine any outstanding items and/or items that are note in conformance with the approved drawings and specifications. Once the incomplete and non-compliant items are identified and any life safety items are corrected, the General Contractor is to request documentation of substantial completion from the design team. Identified remaining punch list items can be addressed by:

1. Reinspection: 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.

C. Substantial completion indicates that:

1. The actual work in place is complete so that the Tenant may use or occupy the building project or designated portion thereof for the intended purpose.
2. The final punch list has been issued

D. Substantial Completion date, inclusive of all temperature zones, marks the beginning of the warranty period.

1.4 FINAL COMPLETION PROCEDURES

A. Preliminary procedures: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final application for payment with full schedule of values

2. Submit certified copy of substantial completion inspection list of items to be completed or corrected (punch list), endorsed and dated by construction manager. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report and warranty.
5. Instruct Tenant's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, construction manager will either proceed with inspection or notify contractor of unfulfilled requirements. Construction manager 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. Reinspection: Request reinspection when the work identified in previous inspections as incomplete is completed or corrected.

1.5 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. General Contractor to coordinate Punch List into a single format which is to include list from all parties associated with this project. Update Punch List of incomplete items on Tenant designated website (ACC).
2. Items are to be updated on the website with photos/documents as they are completed.

1.6 TURNOVER PACAKGE (TOP) BASELINE REQUIREMENTS

A. The GC has responsibility for collection of the TOP documents and for providing them in the following manner.

B. Phase 1: Records will be turned over prior to the transition of the site and will contain the following: Emergency contact list, construction drawings, warranty information if available. Unless otherwise specified, they should be provided in an electronic format via cloud or FTP server the same as the final turnover package.

C. Phase 2: Will be a full comprehensive turn over package, Tenant manuals, warranties, as-built, permit cards, full drawings, sub list etc. within 30 days from transition of the site. If the desired timing is not possible, then the GC will work with the CM and transition manager to develop an agreed upon timeline. The specific document requirements will be specified in the document checklist with the specific requirements being defined thru collaboration with the transition manager and cm.

D. Turnover quantities (TQ), distribution instructions and formatting requirements. The subsequent table prescribes the turnover elements and Minimum quantities required.

TURNOVER ELEMENT	QUANTITY
DRAWINGS (HARDCOPY)	1
ELECTRONIC MEDIA	ACCESS TO CLOUD TYPE STORAGE OR EXTERNAL MEDIA

The hardcopy drawing set will be delivered to the site and given to the Reliability Maintenance Engineering (RME) team.

1.7 OPERATIONS & MAINTENANCE MANUALS DOCUMENTATION

A. Operations & maintenance manuals will be provided in PDF format. PDF files will be part of the “electronic media” elements Documentation directory

B. Electronic delivery of the top electronic media will be the responsibility of the GC, and will be delivered via GC provided cloud based data transfer where the data is formatted as outlined below; with access provided to the transition team, as well as representatives from the 3p. This access will be utilized to obtain a copy of the documents, and the GC can remove system access once the project is fully closed and all documents have been received.

C. The folder structure for the electronic files needs to follow the outline of the document checklist and a folder structure template will be provided on WorkDocs. If the section is not applicable, n/a, then mark it as such in the directory and leave the section blank. Items marked as not received, but which will be available at a later date will have an estimated time of completion (ETOC) and any additional information annotated in the “notes” section of the document checklist.

D. Utility and Equipment Shut-off and Start-up Procedures form is to be completed and delivered to the Construction Manager prior to project launch.

1.8 LIEN WAIVERS

A. The GC shall provide conditional (progress) and unconditional (final) lien waivers and all other assurances or certifications required to evidence that all subcontracts have been paid in full and all lien rights have been waived. The specific criteria for these documents will vary from state to state and will be the deciding factor on the specific document format and content. However, the following would be typical requirements:

1. Lien waivers will reflect the amount paid to whom, and stating:

a. All lien rights against the property for the improvement work have been waived
b. Amounts listed on the lien waivers are correct, and/or
c. No other subcontractors are owed

B. They will be delivered to the applicable Tenant’s representative for approval and storage. It is also understood that in some cases they will not be available within the 30 day requirement for all other documentation. In these cases, it is the responsibility of the GC to provide the ram with contact information of the responsible party that will provide the lien waivers at the earliest possible date.

1.9 ELECTRONIC MEDIA SETS

A. Electronic filing system: Migration of project documentation into a paperless central repository for archival purposes is a requirement before a project is closed. If the original electronic copies of documents are not available, the contractor must scan hard-copy documents and provide them in adobe acrobat PDF format.

B. All project files shall be placed on Tenant's specified web site by the General Contractor. General Contractor to verify with the Tenant that they have access to the required folders a minimum of 30 days prior to turnover.

C. General contractor to supply all turnover documentation in the required folder structure provided on Tenant specified website. All file naming shall clearly identify the site and document title. The site shall be displayed as "SSSN" where "SSS" refers to the three letter site code and "N" represents the site number. A document turnover checklist has been provided in Tenant specified website which includes, but is not limited to, documents that should be provided by the general contractor. All turnover documents are to be recorded by the general contractor in the document turnover checklist and are to follow the file naming convention.

D. Electronic media

1. Delivery of TOP electronic media can be delivered in one of the following:

   a. Preferred method: cloud-based data transfer where the data is formatted as outlined below with read only access provided to the transition team as well as a representative from the 3p. They will then use this access to obtain a copy of the documents, then the access can be removed if desired.
   b. If the cloud-based transfer is not available, then a high-quality, high-capacity solid-state-memory USB flash-drive(s) is acceptable. See instructions below for this method.

2. TOP files shall include electronic images for each document contained in the binders, filed in the folder structure outlined in the folder structure zip file and utilizing the standard file naming convention. A project shall remain open until each file is received and accepted by Tenant's construction and transition manager. Should the GC and/or CM determine a file is unavailable or too cost prohibitive to obtain, the document may be marked as not available (n/a). A written communication, including a statement of facts shall be included in lieu of the missing document.

3. If removable media is the preferred delivery mechanism (as determined by the CM), the following are mailing instructions for the delivery of the electronic media sets:

   a. Mail a completed electronic document set on a thumb drive to:

      (Obtain the specific mailing address from the transition manager)

   b. Once the documents have been shipped, the tracking numbers need to be distributed to the following personnel:

      1) The recipient of the package
      2) Construction manager
      3) Transition manager

1.10 TRAINING VIDEOS

A. Video training shall consist of well-produced mp4-formatted video recorded sessions of in-person live training sessions. All training videos shall be included in the turnover documentation and shall follow the naming convention for electronic media sets. Training videos shall be:

1. Narrated in clearly spoken English (unless alternate local language as requested)
2. Sectioned into the following aspects where applicable for each major equipment:

a. Equipment component identification
b. Equipment safety

1) Lock-out procedures
2) Emergency shut-off
3) Safe operating & maintenance procedures

c. Normal operating sequences
d. Service & maintenance operating sequences

1) Periodic maintenance
2) Major service

e. Other pertinent operational, safety & maintenance related items that can be live demonstrated.

1.11 EAM DATA

A. There are three primary types of enterprise asset management (EAM) data required in the TOP, which includes the following: equipment master data, recommended maintenance (preventative maintenance and predictive maintenance), and recommended spare parts.

B. The developer / general contractor is responsible to provide only the master equipment data (MED). A MED template will be provided by Tenant and will require the following data being populated: site, equipment type, equipment name, building location, manufacturer, model, serial #, installation date, and in some cases up to 2 other field of data specific to the equipment type. The typical types of equipment included would be the following: HVAC, dock equipment, generators, electrical, electrical panels, MDF infrastructure, fire systems, fire other, and other miscellaneous building system and major equipment. (below is an example data input sheet for “electrical” equipment)

1.12 ARCHIVING & RETENTION

A. An electronic copy of the project documentation will be maintained by the GC for a minimum of 1 year after the final turnover of the building to Tenant. This will be in the same form of the cloud drive with the prescribed folder structure and will be available to Tenant upon request.

1.13 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 Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

C. 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 ACC web site.
2. Provide dividers 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 file title "WARRANTIES," Project name, and name of Contractor.

D. Provide additional copies of each warranty to include in operation and maintenance manuals.

E. Coordinate with Tenant Construction Manager for scheduling of Warranty Walk.

1. Two months prior warranty expiration for items with one year warranties.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following.

1. Operation and maintenance documentation history.
2. Emergency Manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Product maintenance manuals.
5. Systems and equipment maintenance manuals.

B. Operation and maintenance data shall be submitted in appropriately sized 3-ring binders, with dividers, and organized by each piece of equipment or system.

C. Project specific, information only, operation and maintenance data shall also be scanned to electronic PDF format using the same layout and format described below and uploaded to ACC website.

D. Operation and maintenance data include the following:

1. Title page.
2. Spine label.
3. Table of contents.
4. Contact information.
5. Contents specific to type of manual (equipment and systems, or materials and finishes).

E. Store operation and maintenance data in the field office apart from documents used for construction. Do not use closeout submittal data for construction purposes. Maintain closeout submittal data in good order and in a clean, dry, legible condition. Make all closeout submittal data available at all times for the owner's and A/E's inspections.

F. Each contractor is responsible for obtaining, recording, and maintaining operation and maintenance data applicable to its own work. The general contractor is responsible for coordinating information, where information from more than one contractor is to be integrated with information from other contractors to form one closeout submittal.

G. A complete printed copy of all operation and maintenance in good order and in a clean, dry, legible condition is to be provided in an appropriately sized 3-ring binder and as outlined above and left on site in the Manager’s Office at turnover.

1.2 RELATED REQUIREMENTS

A. Section 013300 – Submittal Procedures

B. Section 017839 - Project Record Documents

PART 2 - PRODUCTS

2.1 MANUALS - GENERAL

A. Format and organization:

1. Format:

a. Binders: Heavy-duty, 3-ring, vinyl-covered binders, in thickness to match contents, sized to hold 8.5”x11” paper. Use multiple binders if contents are over 3” thick.
b. Binder dividers: Heavy-paper dividers with plastic-covered tabs for each section.
c. Drawings:

1) 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.
2) Do not use original project record documents as part of operation and maintenance manuals.
3) Comply with requirements of newly prepared Record Drawings in Section 01.78.23 Project Record Documents.
4) If oversize drawings are necessary, fold drawings to same size as text pages and use as fold-outs. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes.

2. Organization:

a. Separate manuals by specification division. No manual should cover more than one specification division.
b. Divide each specification division by specification section.
c. Divide each specification section by piece of equipment (using equipment ID).

B. General requirements. Each manual shall contain:

1. Cover and title page. Include the following:

a. Official project name.
b. Official project number.
c. Words “Operation & Maintenance Manual”.
d. Specification section covered, including number and name.
e. Name of contractor.
f. Date of submittal.
g. Short list of contents.

2. Spine label. Include the following:

a. Official project name.
b. Words “Operation & Maintenance Manual.”
c. Specification section covered, including number and name.
d. Date of submittal.

3. Table of contents. Include the following:

a. List each item included in the manual, identified by product name and specification section

4. Contact information. Include the following:

a. List each contractor's name, contact, address, phone, and e-mail for each item covered, including emergency contact information.

5. Contents specific to manual type. See section below.

C. Manual type: Equipment and Systems Manuals. Include the following contents:

1. Manufacturer's product data for each major component. Include the following:

a. Significant design criteria.
b. List of equipment components.
c. Product name, model number, and serial number, if applicable. If product data sheets contain information about multiple products, mark each sheet to identify product incorporated into work in such a way as to be reproducible with black and white copying.
d. Manufacturer's name.
e. Equipment function description.
f. Operating characteristics.
g. Limiting conditions.
h. Performance curves.
i. Engineering data and tests.
j. Wiring, piping and control diagrams. Include color-coding key where required.
k. Troubleshooting guide. Preferably include chart with three columns (malfunction, probable cause, recommended action). Troubleshooting instructions shall be predicated upon a logical effect-to-cause philosophy and a rapid replacement procedure to minimize equipment downtime.
l. License requirements including inspection and renewal dates.
m. Manufacturer's installation instructions for each major component. Include instructions that ship with the unit.

2. Manufacturer's operational instructions for each major component. Include the following:

a. Operating procedures, including sequence of operation for normal, seasonal, and special condition operations. Include start-up, break-in, and shut-down procedures. Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.
b. Operating instructions that ship with the unit.
c. Checklists.
d. Operating logs, if recommended.
e. Precautions against improper use.

3. Supplemental shop drawings for entire equipment or system. Coordinate with information in record contract drawings to ensure correct illustration of completed installation. Illustrate the following:

a. The relationship of equipment components and system components to each other.
b. Control sequences.
c. Flow diagrams.
d. If control drawings, include full points list, set point schedules, and set points after calibrations performed by contractor (not commissioning).

4. Manufacturer's preventive maintenance instructions for each major component. Include the following:

    a. Maintenance procedures, including test and inspection instructions, disassembly instructions, cleaning, minor repairs, and adjusting instructions that detail essential maintenance procedures. Include test points and values, and sensor calibration requirements and methods.
    b. Maintenance and service schedules, including service and lubrication requirements, list of lubricants for equipment, cleaning, and separate schedules for preventive and routine maintenance and service with standard time allotment.
    c. Spare parts documentation, including spare parts list, parts diagrams, complete nomenclature and number of parts, replacement and repair parts, parts identified and cross-referenced to maintenance documentation, and local sources of maintenance materials and related services.
    d. Maintenance service contracts, including copy of service agreement and service agent name and contact information.
    e. Exploded equipment views.
    f. Precautions against improper maintenance.

5. Warranties and bonds. Include the following:

    a. Warranty and/or bond.
    b. List of circumstances and conditions that would affect validity of warranty or bond.

6. Functional performance tests. Include the following:

    a. Start-up record.
    b. Copies of required tests, when required in Divisions 2 through 48 or when otherwise applicable (not including test & balance reports - see Section 01 33 23), including submitting additional copies directly to governing authorities.

7. Safety precautions. Include the following:

    a. List of precautions to be following before, during, and after operation, maintenance, or emergencies.
    b. Provide equipment- and/or system-specific lockout/tagout procedures for the isolation of hazardous energy and materials including but not limited to electrical, hydraulic, chemical, mechanical, pneumatic, thermal, gravitational, potential, and hazardous materials. Include the following:

        1) Equipment id(s) and description(s)
        2) Location: building name, building number, location in building
        3) Steps for each type of energy source required for isolation
        4) Equipment id
        5) Lockout location (description and photo or diagram)
        6) Energy source
        7) Lockout device(s)
        8) Lockout method
        9) Verification

D. Manual type: Materials and Finishes. Include the following contents:

1. Manufacturer's product data. Include the following:

a. Product name and model number. If product data sheets contain information about multiple products, mark each sheet to identify product incorporated into work in such a way as to be reproducible with black & white copying.
b. Color, pattern, size and texture.
c. Material and chemical composition.
d. Reordering information for specially manufactured products.

2. Manufacturer's maintenance procedures. Include the following:

a. Inspection procedures.
b. Schedule for maintenance.
c. Types of cleaning agents.
d. Methods of cleaning.
e. Schedule for cleaning.

3. Manufacturer's recommended repair materials and sources. Include the following:

a. List of repair materials.
b. List of local sources of materials and related services.
c. Repair instructions.

4. Warranties and bonds. Include the following:

a. Warranty and/or bond.
b. List of circumstances and conditions that would affect validity of warranty or bond.

E. Manual type: Emergency Manuals:

1. Content: Organize manual into a separate section for each of the following:

a. Type of Emergency.
b. Emergency instructions.
c. Emergency procedures.

2. 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:

a. Fire.
b. Flood.
c. Gas leak.
d. Water leak.
e. Power failure.
f. Water outage.
g. System, subsystem, or equipment failure.
h. Chemical release or spill.

3. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
4. Emergency Procedures: Include the following, as applicable:

a. Instructions on stopping.
b. Shutdown instructions for each type of emergency.
c. Operating instructions for conditions outside normal operating limits.

d. Required sequences for electric or electronic systems.
e. Special operating instructions and procedures.

PART 3 - EXECUTION

3.1 RECORDING

A. During construction, maintain a set of operation and maintenance data specifically for the purpose of creating close-out submittals separate from the set used for construction

B. Maintain operation and maintenance data in good order and in a clean, dry, legible condition.

C. Mark operation and maintenance data to indicate actual work details.

D. Mark important additional information that was either shown schematically or omitted from contract documents.

E. Mark operation and maintenance data completely and accurately.

F. Mark operation and maintenance data in such a way as to be reproducible in black and white copying.

G. Make all operation and maintenance data available at all times for the owner's and A/E's inspections.

3.2 RESPONSIBILITY FOR MARKUP

A. The individual or entity responsible for the work involving the equipment, system, or product is responsible for maintaining operation and maintenance data closeout submittals.

1. Record changes and modifications as they occur - do not wait until the end of the project.
2. Record and check the markup prior to enclosing concealed installations.

3.3 SUBMISSION AND DISTRIBUTION

A. After completing work, prepare operation and maintenance data closeout submittals for submission.

1. General Contractor is responsible for coordinating with all sub-contractors for submittal of operation and maintenance manuals and data.
2. Each contractor is responsible for submitting operation and maintenance data closeout submittals to the General Contractor.
3. Each contractor shall submit all operation and maintenance manuals related to each contractor's particular work, whether or not changes and additional information were recorded.
4. For equipment that requires commissioning, general contractor shall submit the following:

a. One (1) copy of the Operation and Maintenance Manual to the commissioning agent a minimum of 7 days prior to commissioning.
b. One (1) draft copy of the Operation and Maintenance Manual to the A/E for review by the A/E and contracted commissioning agent within fourteen (14) calendar days after review of equipment shop drawings. Copies will be returned to the general contractor within ten (10) days after receipt by the A/E and contracted commissioning agent, along with review comments. Manuals must be submitted no later than thirty (30) days prior to final requirements in paragraph 4.

5. Prior to substantial completion, the general contractor shall submit the following Operations and Maintenance Manuals:

    a. (1) hard copy binder to be left in the project site Manager's Office
    b. (1) PDF copy to be uploaded to Owner specified website

6. Transmit each submittal by use of a transmittal form.

END OF SECTION 017823

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SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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 017700 "Closeout Procedures" for general closeout procedures.
2. Section 017823 "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.
2. Number of Copies: Submit copies of Record Drawings as follows:

a. Initial Submittal:

1) Submit PDF electronic files of scanned record prints and one set(s) of file prints.

b. Final Submittal:

1) Submit Record Digital Data Files and one set(s) of Record Digital Data File plots.

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. Reports: Submit written report 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 prints 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 and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Annotated PDF electronic file with comment function enabled.
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.

C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: 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.
4. 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 scanned PDF electronic file(s) of marked-up paper copy of Specifications.

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 scanned PDF electronic file(s) of marked-up paper copy of Product Data.

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 scanned PDF electronic file(s) of marked-up miscellaneous record submittals.

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

3.1 RECORDING

A. During construction, create and maintain a separate set of as-built documents to reflect the installed and constructed condition of the project.

B. Maintain as-built documents in good order and in a clean, dry, legible condition.

C. Mark as-built documents to indicate actual work done that deviates from the contract drawings.

D. Mark important additional information that was either shown schematically or omitted from contract documents.

E. Mark as-built documents completely and accurately.

F. Mark as-built documents with red erasable colored pencil or approved electronic format. Use other colors to distinguish between changes for different categories of the work at the same location. All marks shall be photo-reproducible.

G. Reference any changes to the contract, including but not limited to addenda, change orders, change directives, supplemental instructions, and other issued modifications. Use specific document numbers.

H. Make all documents and samples available at all times for the owner's and AE's inspections.

3.2 RESPONSIBILITY FOR MARKUP

A. The individual or entity who obtained as-built data, whether the individual or entity is the installer, contractor, subcontractor, or similar entity, shall record the markup.

B. Record changes and modifications as they occur - do not wait until the end of the project.
C. Record and check the markup prior to enclosing concealed installations.

END OF SECTION 017839

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SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. Demonstration of products and systems where indicated in specific specification sections.

B. Training of Owner personnel in operation and maintenance is required for:

1. All software-oriented systems.
2. Landscape irrigation system.
3. Loading dock equipment.
4. HVAC systems and controls.
5. Plumbing equipment.
6. Electrical power distribution and equipment.
7. Electrical lighting controls.
8. Fire protection system and fire pump.
9. Emergency generator.
10. Fire alarm system.
11. Motorized gates and traffic arms.

1.2 RELATED REQUIREMENTS

A. Section 013300 - Submittal Procedures

B. Section 017700 - Closeout Procedures

C. Section 017839 - Project Record Documents

1.3 SCOPE OF TRAINING

A. Training must include both classroom and on-the-job (hands-on) instruction, by qualified manufacturer's representatives, vendors, installation/service technicians, and operation personnel having the necessary knowledge, experience, and teaching skills.

1. Scheduling must be coordinated and confirmed with the project manager prior to substantial completion. Project manager to coordinate with Tenant reliability maintenance and engineering (RME) rep.
2. In addition to respective sections where specified, a minimum of one (1) full day of onsite classroom style instruction is required.
3. In addition to respective sections where specified, a minimum of one (1) full day of on-the-job (hands-on) instruction is required.

B. The training shall provide comprehensive instruction on the operation and maintenance of building components, equipment, controls, and systems including procedures for routine startup, shutdown, normal operation, abnormal operation, preventive maintenance, troubleshooting, and corrective maintenance.

C. All training sessions will be recorded by the contractor if required by the contract documents and one copy for each O&M manual of the recording are to be provided to the RME manager at the conclusion of the training session. Format for submitted video recording shall be determined by the RME manager.

D. Follow-up or post-occupancy training, where specified, shall be planned, scheduled, and conducted per the requirements of this specification. This training will focus on seasonal issues that could not be addressed during the initial training and on addressing operational and maintenance issues identified by the owner since turnover.

1.4 COORDINATION AND SCHEDULING

A. Training shall not begin until the following items have been completed:

1. Building systems and equipment are complete and operational.
2. The project manager and/or RME manager has received and approved the final submittal copies of the operation and maintenance manuals
3. The contractor's proposed training plan and schedule have been approved by the RME manager.

B. The contractor shall work closely with the owner's personnel and the commissioning agent in the development and implementation of the training program. This may include preliminary meetings to map out the direction the training will take and development, with project manager approval, of the written training materials.

C. The minimum specific hours of training time provided for each category of major equipment and systems shall be in accordance with the specification sections pertaining to this equipment or systems. Where training session duration (hours) are not provided in the specifications, contractors shall coordinate with the RME manager for developing the hours of instruction and scope of material to be covered.

D. The RME manager retains the option of redistributing training time, subject to the total time specified. This may include repetition of selected training sessions or provision for follow up training sessions after occupancy.

E. Training must be presented on an 8-hour per day, 5-day per week schedule, with all reading assignments and review to be within this period.

F. Mutually agreeable dates for training shall be arranged with RME manager, but the training shall be completed before occupancy or final acceptance.

G. Specific schedules for all training sessions must be coordinated in advance with the owner.

1.5 TRAINING PROGRAM AND MATERIALS

A. The contractor will submit a written training program outlining the proposed scope of training, training materials and instruction schedule for review and approval by the RME manager approximately 30 days before the scheduled completion of the work for which training is to occur.

B. The commissioning team will provide sample training session guidelines and agendas for use by the contractors in developing their training programs where applicable.

C. Copies of training materials furnished by the contractor as part of their training program shall become the property of the owner. This includes but is not limited to:

1. All lesson plans, teachers' guides or training aids used to instruct the students. One complete set shall be given to the owner.

2. All written materials e.g. workbooks, manufacturers' instructions, brochures, student tests, charts or other printed or photographed visual aids. Three (3) sets with one complete reproducible master shall be given to the owner.
3. All audio visual materials (e.g. digital recordings). One set shall be given to the RME manager.
4. Identification of each training session, date, time, and duration.
5. Sign-in sheet showing names and job titles of attendees.
6. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.

1.6 INSTRUCTOR QUALIFICATIONS

A. Credentials of training instructors are subject to review and approval by the RME manager.

B. Instructors must have knowledge and experience with the equipment on which they are providing training.

C. Instructors must be familiar with the organization and content of operation and maintenance manuals for the equipment on which they are providing training.

D. Instructors for controls must be knowledgeable and familiar with the specific controls equipment, project applications, and specific sequences of operation for this project. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.

1.7 CLASSROOM TRAINING FACILITIES

A. Locations for classroom training sessions shall be coordinated and scheduled with the Regional Portfolio Manager (RPM). All training shall be conducted on-site.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION

3.1 DEMONSTRATION – GENERAL

A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

B. Demonstration may be combined with Owner personnel training if applicable.

C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.

1. Perform demonstrations within two weeks after Substantial Completion.

D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.

3.2 DEMONSTRATIONS WITHIN TWO WEEKS AFTER SUBSTANTIAL COMPLETION

A. Conduct training on site unless otherwise notified.

B. Provide training in minimum two-hour segments.

C. Training schedule will be subject to availability of Owner's personnel to be trained; re- schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.

D. Review of Facility Policy on Operation and Maintenance Data: During training discuss:

1. The location of the O&M manuals and procedures for use and preservation; backup copies.
2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
3. Typical uses of the O&M manuals.

E. Product- and System-Specific Training:

1. Review the applicable O&M manuals.
2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
3. Review instructions for proper operation in all modes, including start-up, shut- down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
4. Provide hands-on training on all operational modes possible and preventive maintenance.
5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
6. Discuss common troubleshooting problems and solutions.
7. Discuss any peculiarities of equipment installation or operation.
8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
9. Review recommended tools and spare parts inventory suggestions of manufacturers.
10. Review spare parts and tools required to be furnished by Contractor.
11. Review spare parts suppliers and sources and procurement procedures.

F. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION 017900

SECTION 01 9113 - GENERAL COMMISSIONING REQUIREMENTS V1.0

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Design Criteria, Template Drawings, Owner's Commissioning Plan and Scope, Special Conditions and Forms, and Division 01 Specifications Sections apply to this section.
B. Owner's Project Requirements and Basis of Design (BOD) documents - for information only.

1.2 SUMMARY

A. An independent commissioning provider (3PCx) has been retained to implement and coordinate commissioning process for this project. The objectives of the commissioning process are to:
   1. Achieve, verify and document that performance of facilities, systems, and assemblies meet defined objectives and criteria.
B. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, operation and occupancy meet Owner's Project Requirements.
C. This section defines members of Commissioning Team (CxT) and outlines responsibilities of each member of CxT. All CxT members work together to fulfill their contracted responsibilities and meet objectives of contract documents.
D. The commissioning process does not take away from or reduce responsibility of system designers or installing contractors to provide a finished and fully functioning product.
E. Participating CxT entities shall each include cost to complete their portion of commissioning process in their proposal.

1.3 COMMISSIONED SYSTEMS

A. Mechanical (if applicable):
   1. 100 percent Air Cooled Units (RTU/CRAC).
   2. Gas Detection System - including but not limited to H2, NOx, CO.
   3. Humidifier/Dehumidifier.
   4. 100 percent Electric Wall Heaters.
   5. 100 percent Electric Ceiling Heaters.
   6. 100 percent Circulation Fans (Permanently installed HVLS, Patterson, other).
   7. 100 percent Exhaust Fans.
   8. 100 percent VAVs.
   9. Fire Suppression System startup reports shall be collected and reviewed for completeness.
   10. Plumbing Systems (Sewer lines & pumping station).
      a. 100 percent Domestic Water Booster Pumps
      b. 100 percent Hot Water Recirculation Pumps
      c. 100 percent Water Heaters and appurtenances
      d. 100 percent Plumbing Fixtures (Faucets/Water Closets/Urinals)
      e. 100 percent Water Coolers (If not owner provided.)
      f. Waste/Septic Validation (For existing buildings both pre/post construction validations are required.)
   11. 100 percent Indoor Air Quality Devices (CO2, RH, T).
   12. BMS.
   13. Guard house and all applicable systems.

B. Electrical (if applicable):

   1. Power Generation.
   2. UPS.
   3. PDU.

4. EPO.
5. 100 percent Lighting and Lighting Control Systems - including daylight, occupancy and time-of-day.
6. 20 percent Panel boards 100 amp and larger.
7. 20 percent Panel boards under 100 amps.
8. 100 percent Switchboards.
9. 100 percent Transformers.
10. Power Monitoring - including mains and sub-panels.
11. Surge Protection Devices.
12. Busways.
13. Transfer Switches.
14. Arc Flash Coordination Studies (pre -MHE installation).
15. Solar (if owned by Owner).

C. Fire Protection Systems - Review Documentation Completed by Others:
1. Fire suppression systems.
2. Fire alarm systems.
3. Smoke removal systems (where provided).

D. Base Building Systems: All equipment to be verified with no sampling.
1. Dock Door Assembly
   a. Leveler
   b. Door Open/Close Spring Tension
   c. Photo Eyes/Sensors
   d. Dock Lock
   e. Combination Fan/Light Unit
   f. Door Lock
2. High-Speed Roll Up Doors (HSRUD) - Inner Door
   a. Photo Eyes/Sensors
   b. Auto Reversing Crush Edge
   c. Audible Alarms
   d. Smooth Operation
   e. Countdown Timer
   f. Control Buttons
   g. High-Speed Roll Up Doors (HSRUD) - Outer Door
   h. Photo Eyes/Sensors
   i. Auto Reversing Crush Edge
   j. Audible Alarm
   k. Smooth Operation
   l. Control Buttons

1.4 DEFINITIONS

A. Acceptance: A formal action taken by a person with appropriate authority (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.

B. Basis of Design: A document that records concepts, calculations, decisions, and product selections used to meet Owner's Project Requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

C. Checklists: Verification checklists that are developed and used during all phases of commissioning process to verify that Owner's Project Requirements are being achieved. This includes checklists for general verification plus testing, training, and other specific requirements.

D. Commissioning or Commissioning Process: A quality-focused process for enhancing delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet Owner's Project Requirements.

E. Commissioning Process Activities: Components of commissioning process.

F. Commissioning Process Progress Report: A written document that details activities completed as part of commissioning process and significant findings from those activities, which is continuously updated during the course of a project.

G. Commissioning Provider: The entity identified by Owner who plans, schedules, and coordinates commissioning team to implement commissioning process.

H. Commissioning Request for Information (RFI): Form used by 3PCx to request information from design and construction team.

I. Commissioning Team: The individuals who, through coordinated actions, are responsible for implementing commissioning process.

J. Coordination Drawings: Drawings showing work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.

K. Deferred Performance Tests (DPTs): Performance tests that are performed at the discretion of 3PCx3PCx after Substantial Completion due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that do not allow the test to be performed.

L. Deficiency: A condition in installation or function of a component, piece of equipment, or system that is not in compliance with the contract documents.

M. Document Request Log: A log maintained by 3PCx to list and track documents requested from design and construction team.

N. Factory Testing: Testing of equipment on site or at the factory by factory personnel with or without an Owner's representative present.

O. Functional Performance Test: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment assemblies, systems, and interfaces among systems.

P. Issues Log: A formal and ongoing record of problems or concerns - and their resolution - that have been raised by members of commissioning team during course of the commissioning process.

Q. Non-Compliance: See Deficiency.

R. Non-Conformance: See Deficiency.

S. Owner's Project Requirements: A written protocol that details functional requirements of a project and expectations of how it will be used and operated. This includes project and design goals, measurable performance criteria, and supporting information.

T. Phased Commissioning: Commissioning that is completed in phases as required by phasing plan as approved for the project and other scheduling issues.

U. Pre-Functional/Startup Checklist: A form used by Contractor to verify that appropriate components are on site, ready for installation, correctly installed, and functional.

V. Seasonal Performance Tests: Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.

W. Third Party Testing Vendor (3PTV): Performs system specific testing following scope noted in applicable specification section. See individual specification sections for details.

X. Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in Owner's Project Requirements.

1.5 SUBMITTALS

A. The 3PCx will provide Contractor with a specific request for the type of submittal documentation 3PCx requires facilitating the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction project. All documentation requested by 3PCx will be included by Contractor in the O&M Manual.

B. The 3PCx will review submittals related to commissioning of equipment for conformance to contract documents as it relates to commissioning process, to performance of the equipment, and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance test procedures and only secondly to verify compliance with equipment specifications. The 3PCx will follow communications protocol to notify those required of items missing or areas that are not in conformance with contract documents and which require submission.

C. 3PCx shall receive submittals reviewed by Architect/Engineer. 3PCx will provide comments, when required, to Architect/Engineer for inclusion in future addendums to contractors.

D. Shop Drawings:

1. Include a complete bill of material of equipment used indicating quantity, manufacturer and model number and other relevant technical data.
2. Include manufacturer's description and technical data, such as performance curves, performance test procedures, product specification sheets, schedules, settings and installation, operation and maintenance instructions, and detailed startup procedures.
3. Submittals shall contain outline dimensions, layout details, operating and maintenance clearances, and sufficient engineering data to indicate compliance with the specifications.
4. Scale and Measurements: Make shop drawings accurately to a scale sufficiently large to show all pertinent aspects of the item and its method of connection to the work.
5. Each piece of equipment shall be identified by the number shown in the schedules and specification article number pertaining to the item. Shop drawings shall, at a minimum, be 1/4-inch equal 1'-0" scale (1:50), and shall be newly prepared by Contractor and not reproduced from Architect/Engineer's drawings.
6. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project will be highlighted or clearly indicated by other means. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.
7. Shop drawings to be provided to 3PCx include, at minimum, all applicable systems identified within section 1.3 COMMISSIONED SYSTEMS.

E. The 3PCx may request additional submittals/information not listed above and design narrative from Architect/Engineer, Contractor, and/or equipment suppliers, etc.

F. Submittals to 3PCx do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though 3PCx will review and approve them.

1.6 COMMISSIONING TEAM

A. Members appointed by Contractor: Individuals, each having expertise and authority to act on behalf of the entity he or she represents, explicitly organized to implement commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by 3PCx.

1. Developer and Tenant to review list of Cx providers and shortlist firms to provide proposals.
2. The Cx provider proposals are reviewed by Owner and Developer/General Contractor, and are hired by Developer/General Contractor.

B. Members appointed by Owner:

1. 3PCx: An entity empowered by Owner who leads, plans, schedules, and coordinates commissioning team to implement commissioning process.
2. Representatives of facility user and operation and maintenance personnel.
3. Architect and engineering design professionals (A/E).

C. Members of Commissioning Team, at minimum, to include:

1. Construction Manager.
2. Reliability and Maintenance.
3. Architect/Engineer (A/E).
4. Contractor.
5. Mechanical Subcontractor.
6. Major HVAC Equipment Suppliers.
7. Instrumentation and Controls Subcontractor.
8. Instrumentation and Controls Supplier.
9. Third party testing vendors (3PTV)
    a. Test and Balance Subcontractor
    b. Electrical Testing Specialty Contractor (See Specification Section 260805 - Electrical Quality Specification)
    c. Plumbing Inspection Contractor
10. Commissioning Provider.

D. Preferred Commissioning Vendors with negotiated pricing:

1. Emanuelson-Podas
    a. Eric Rose
    b. erose@epinc.com
    c. Cell: 612.385.7096
    d. Mathieu Lindquist, PE
    e. mlindquist@epinc.com
    f. Cell: 612.346.2030

2. Kimley-Horn
    a. Anthony Hughes
    b. Anthony.hughes@kimley-horn.com
    c. Cell: 612.715.9680
    d. Brittany Jaramillo, PE, HBDP
    e. Brittany.Jaramillo@kimley-horn.com
    f. Cell: 612.389.9996

3. Henderson Building Solutions
    a. Dustin Harmon
    b. dustin.harmon@hendersonbuilding.com

c. Cell: 913.742.5704

4. Command Commissioning
   a. Ken Meline, PE
   b. kmeline@command-cx.com
   c. Main: 817.688.0733

5. Noresco
   a. Tim Rose
   b. trose@noresco.com
   c. Cell: 732.312.7386
   d. Ken Carlson
   e. kcarlson@noresco.com
   f. Cell: 732.489.4266
   g. Kevin Perri
   h. kperri@noresco.com
   i. Cell: 720.943.0806

1.7 RESPONSIBILITIES

A. All CxT Members:

1. Attend preconstruction commissioning meeting and regularly scheduled construction meetings by phone, or in person, as necessary.
2. Cooperate with all CxT members to carry out commissioning process.
3. Include the price of commissioning responsibilities/tasks in each CxT member's proposal.

B. Commissioning Provider (3PCx):

1. Coordinates and directs commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, updated timelines, schedules, and technical expertise.
2. The 3PCx shall develop specific commissioning documentation. ~~A~~All commissioning documents shall be kept in an online portal with individual access provided to team members. All pages shall be numbered, and a table of contents page(s) shall be provided. The 3PCx developed commissioning documentation shall include, but not be limited to, the following:

   a. Commissioning schedule.
   b. Commissioning RFIs.
   c. Issues log.
   d. Pre-functional/startup checklists.
   e. Functional performance test procedures.
   f. Commissioning team meeting minutes.
   g. Final commissioning report.

2. Additional documentation required of the commissioning process that 3PCx shall verify is in place and review (when contracted to do so) includes the following:

   a. Owner's Project Requirements document.
   b. Basis of Design document.
   c. Shop drawing submittals.
   d. As-built documentation.
   e. Test and balance reports.
   f. Results of factory tests specified in Divisions 23 and 26 Sections of this specification for construction.

g. Results of tests specified in Divisions 23 and 26 Sections of this specification for construction.

3. The 3PCx may assist with problem solving, non-conformance or deficiencies, but ultimately that responsibility resides with Contractor and Architect/Engineer.
4. The 3PCx is not responsible for design concept, design criteria, compliance with codes, review or approval of change orders, design or construction scheduling or cost estimating.
5. The 3PCx coordinates commissioning work and, with Contractor, ensures that commissioning activities are being incorporated into the construction schedule maintained by Contractor.
6. Plans and conducts a pre-construction commissioning meeting and other commissioning meetings.
7. Prepares meeting agendas, meeting minutes and distributes to commissioning team.
8. Requests and reviews additional information required to perform commissioning tasks, including O&M materials and Contractor pre-functional/startup checkout procedures.
9. Reviews normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, subsequent to Architect/Engineer's reviews.
10. Develops a startup, checkout, Contractor-directed test, 3PCx-witnessed test and integrated system test plan with Contractor.
11. Attends selected planning and job-site meetings to obtain information on construction progress. Reviews construction meeting minutes for revisions/substitutions relating to commissioning process. Assists in resolving any discrepancies.
12. Conducts periodic construction observations, as contracted, to verify that systems and equipment are installed consistently with Owner's Project Requirements, Basis of Design and contract documents. Documents deficiencies in issues log and distributes to CxT. (Note: The 3PCx is responsible for identifying deficiencies but is not responsible for ensuring that deficiencies are corrected. 3PCx observations are not intended to take the place of design team observations.).
13. Approves pre-functional checklist/startup completion by reviewing checklist reports and by selected site observation.
14. With necessary assistance and review from Architect/Engineer and Contractor, writes the functional test procedures and integrated systems test procedures for equipment and systems.
15. Reviews control sequences and interlocks and works with Contractor and Architect/Engineer until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
16. Reviews and approves completed Contractor-directed functional performance test forms.
17. Directs and witnesses functional performance.
18. Coordinates retesting as necessary until satisfactory performance is achieved.
19. Analyzes any performance trend logs and monitoring data to verify performance.
20. Reviews test and balance execution plan.
21. Reviews test and balance reports along with Architect/Engineer.
22. Directs and witnesses 3PTV integrated systems testing conducted by Contractor.
23. Recommends acceptance of individual systems and assemblies to Owner.
24. Maintains a master issues log and a separate testing record. Provides Owner, Architect/Engineer, and Contractor with written progress reports and test results with recommended actions.
25. Verifies training of Owner's operating personnel has been completed.
26. Reviews equipment warranties to ensure that Owner's responsibilities are clearly defined.
27. Compiles and maintains commissioning documents.
28. Coordinates and supervises required seasonal or deferred testing and deficiency corrections.

B. Owner:

1. Defines Owner's Project Requirements (OPR), provides interpretations and clarifications to OPR, and provides OPR document to 3PCx and Contractor for information and use.

2. Manages contract of Architect/Engineer and Contractor.
3. Facilitates coordination of the commissioning work by 3PCx, and, with Contractor and 3PCx, ensures that commissioning activities are being scheduled into the construction schedule.
4. Assists with gathering of documents requested of CxT members.
5. Provides Basis of Design documents, approved by Owner, to 3PCx and Contractor.
6. Reviews, comments and approves commissioning plan.
7. Reviews, comments and approves construction documents.
8. Performs review of Contractor submittals.
9. Coordinates site visits and meetings with 3PCx.
10. Attends commissioning meetings, pre-functional/startup procedures, and functional testing.
11. Reviews, comments and approves 3PCx's functional test reports.
12. Provides access to areas of the facility in a timely manner for commissioning team to perform its work.
13. Reviews commissioning progress reports and issues log.
14. Coordinates resolution of non-compliance and design deficiencies identified in all phases of commissioning.
15. Develops final punchlist for the construction project.
16. Reviews and accepts 3PCx's final commissioning report and provides final approval for completion of commissioning work.
17. Ensures that any seasonal or deferred testing and any deficiency issues are addressed.
18. Participates in warranty review activities ten months into 12-month warranty period with other members of CxT.

C. Architect/Engineer (A/E):

1. Provides documentation of design intent/basis of design based on Owner's Project Requirements.
2. Prepares construction contract documents.
3. Specifies and verifies adequate maintenance access for each piece of equipment in design, shop drawings, and in-place installation.
4. Provides system design parameters to Owner and obtains approval.
5. Provides any design narrative documentation requested by 3PCx. This includes clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
6. Notifies 3PCx of substantive changes to contract documents.
7. Reviews and comments on pre-functional/startup checklists, functional performance test procedures, and integrated systems test procedures submitted by 3PCx.
8. Reviews and approves submittals.
9. Provides periodic site observations as contracted.
10. Witnesses testing of selected equipment and systems.
11. Reviews and comments on 3PCx's commissioning progress reports and issues logs.
12. Reviews and approves O&M data and training plan.
13. Reviews and/or prepares as-built documents from Contractor record documents as contracted.
14. Prepares punchlists.
15. Prepares final Basis of Design document.
16. Reviews and approves test and balance plan and reports.
17. Provides designer's intent training for Owner's operating personnel, if included in Architect/Engineer contract.
18. Coordinates resolution of system deficiencies identified during commissioning.
19. Coordinates resolution of design non-conformance and deficiencies identified during
20. warranty period commissioning.
21. Recommends final acceptance of the systems to Owner.
22. Reviews and comments on the final commissioning report.

D. Contractor:

1. The Contractor is responsible for commissioning activities and coordinating all commissioning activities of subcontractors and equipment suppliers.
2. Facilitates coordination of commissioning work by 3PCx and ensures that Contractor, subcontractors, and all other CxT member commissioning tasks/activities are incorporated into the construction schedule.
3. Furnishes a copy of all construction documents, addenda, change orders, requests for information, and approved submittals and shop drawings related to commissioned equipment/systems to 3PCx.
4. Includes requirements for submittal data, O&M data, commissioning tasks and training in each purchase order or subcontract written.
5. Performs review of submittals.
6. Ensures that all subcontractors execute their commissioning responsibilities according to
7. contract documents and schedule.
8. Attends Contractor training conducted by 3PCx concerning commissioning process, forms to be used, testing requirements, commissioning process deliverables and scheduling.
9. Attends CxT meetings.
10. Provides functional testing plan in accordance with procedures supplied in this section.
11. Responds to (in writing) and addresses items documented in the issues log.
12. Notifies 3PCx six weeks in advance of all equipment startup, Contractor-directed testing, and tests required by contract documents.
13. Contractor to certify that equipment/systems have been installed per manufacturer's
14. instructions.
15. Reviews and makes comment on the pre-functional/startup checklists and functional
16. performance test procedures developed by 3PCx.
17. Submits test results for tests required by contract documents, if applicable, including (but not limited to) test and balance, duct leakage tests, plumbing system disinfection certification, fire alarm tests, etc. as performed.
18. Completes pre-functional/startup checkout forms to 3PCx for review and approval.
19. Completes Contractor-directed functional performance testing. This testing mandates
20. participation of Contractor and all subcontractors involved with systems integration, such
21. as mechanical, electrical, and controls subcontractors. Submits completed Contractor
22. directed functional test forms to 3PCx for review and approval.
23. Notifies 3PCx when systems and assemblies are ready for 3PCx-witnessed testing.
24. Remedies any deficiencies identified in pre-functional/startup checklists and Contractor-directed functional performance testing and notifies 3PCx (in writing) that deficiencies have been addressed.
25. Coordinates and facilitates resolution of non-compliance, deficiencies and discrepancies identified in all phases of commissioning.
26. Notifies 3PCx four weeks in advance when test and balancing activities are to start and
27. when their activities have been completed.
28. Provides qualified personnel for performing all test procedures, including functional performance testing witnessed by 3PCx.
29. Performs functional performance testing of assemblies and systems witnessed by 3PCx.
30. Coordinates training of Owner personnel. Develops training agenda, training materials,
31. conducts training sessions. Schedules subcontractors, equipment suppliers, etc. to
32. participate in training Owner's personnel. Coordinates with Owner schedule for training Owner operating personnel.
33. Provides training agenda, materials and schedules to 3PCx for review and comment.
34. Prepares O&M manuals according to contract documents, including clarifying and updating the original sequences of operation to as-built conditions. Submits O&M
35. manuals to 3PCx for review prior to Owner operating personnel training. O&M manuals are to be used in training sessions.
36. Submits complete set of as-built records to 3PCx for review.
37. Ensures that Contractor and subcontractors execute seasonal and deferred functional performance testing, witnessed by 3PCx, according to the specifications.

38. Ensures that Contractor and subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built records for applicable issues identified in any seasonal or deferred testing.
39. Participates in warranty review activities coordinated by 3PCx prior to termination of warranty period.

E. Equipment Suppliers:

1. Provides all requested submittal data, including detailed startup procedures and specific responsibilities of Owner to keep warranties in force.
2. Assists in equipment testing per agreements with Contractor.
3. Includes all special tools and instruments (only available from equipment supplier,
4. specific to a piece of equipment) required for testing equipment according to these
5. contract documents.
6. Analyzes specified products and verifies that Architect/Engineer has specified the newest, most updated equipment reasonable for this project's scope.
7. Provides information requested by 3PCx regarding equipment sequence of operation and
8. testing procedures.
9. Reviews and approves test procedures for equipment installed by factory representatives.
10. Provides personnel, services, documents, tools, etc. for those responsibilities listed under Contractor that are applicable to equipment suppliers.

1.2 COORDINATION

A. The 3PCx shall receive a copy of all construction documents, addenda, change orders, and appropriate approved submittals and shop drawings related to commissioned system/equipment directly from Contractor.

B. The 3PCx shall disseminate written information and documents to all responsible parties relative to the nature and extent of the communication.

C. The 3PCx is primarily responsible to Owner and, as such, shall regularly apprise Contractor and Owner of progress, pending problems and/or disputes, and shall provide regular status reports on progress with each system. Any potential change in the contractual and/or financial obligations of Owner (credits, change orders, schedule changes, etc.) shall be identified and quantified as soon as possible.

D. The 3PCx shall coordinate the schedule of commissioning activities with the construction schedule. It is possible that some procedures will be completed before the entire system is completed.

1.3 SCHEDULE

A. Contractor schedules and scheduling is the responsibility of Contractor. The 3PCx shall provide commissioning scheduling information to Contractor for review and planning activities. 3PCx-developed commissioning activities to be integrated into the construction schedule by Contractor.

B. The schedule shall incorporate sufficient time for the following commissioning process steps:

1. Equipment/systems shall be installed per manufacturer's instructions and industry standards.
2. Pre-functional/startup checklists will be completed by field personnel implementing the startup procedure, field personnel to sign the completed form, and submit signed checklist to 3PCx for review and approval.
3. Contractor Directed Functional Testing: Contractor shall perform functional performance testing of systems/equipment once pre-functional/startup checklists have been approved by 3PCx. Personnel actually carrying out Contractor-directed functional performance testing are to fill out test forms during "Contractor-Directed" testing and the appropriate contracting team personnel shall sign the completed forms. Submit signed, completed forms to 3PCx for review and approval.
4. 3PCx Witnessed Functional Testing: Contractor shall perform functional performance testing to be witnessed by 3PCx after step 3 above has been completed. 3PCx shall complete and sign functional performance test forms for those tests completed in this step.

C. Contractor will integrate all commissioning activities into the overall construction schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite commissioning process.

D. Problems observed shall be addressed immediately, responsible parties notified, and actions taken to correct deficiencies coordinated in a timely manner.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All industry standard test equipment, special tools, ladder/lifts, two-way radios and equipment required for performing the specified tests shall be provided by Contractor and shall be approved by 3PCx. Owner shall furnish necessary utilities for the commissioning process.

B. Any portable or hand-held setup/calibration devices required to initialize the control system shall be provided by the control system subcontractor and equipment supplier for testing.

C. The instrumentation used in the commissioning process shall meet the following standards:

1. Be sufficient quality and accuracy to test and/or measure system performance within the tolerances required.
2. Be calibrated at the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument.
3. Be maintained in good repair and operating condition throughout the duration of use on this project.
4. Be immediately recalibrated or repaired if dropped and/or damaged in any way during use on this project.

2.2 TEST EQUIPMENT - PROPRIETARY

A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or startup, whether specified or not, shall be provided by manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in

the commissioning process as needed. Proprietary test equipment (and software) shall become the property of Owner upon completion of the commissioning process.

PART 3 - EXECUTION

3.1 MEETINGS

A. 3PCx will schedule, plan and conduct an initial commissioning meeting with Contractor. Contractor and its responsible parties are required to attend.

B. Other meetings will be planned and conducted by 3PCx as construction progresses. The meetings will cover coordination, deficiency resolution, and planning issues. These meetings will be held at least monthly until final three months of construction, when they may be held as frequently as one per week.

3.2 CONSTRUCTION OBSERVATION

A. 3PCx construction observation is an additional and separate activity from that provided by the design team. Construction observation is required as part of the commissioning and coordination process to be provided by them.

3.3 TEST AND BALANCE (TAB)

A. Air and water test and balance shall be accomplished by a test and balance firm as specified by Architect/Engineer.

3.4 PRE-FUNCTIONAL/STARTUP CHECKLIST

A. The following procedures apply to all equipment/systems to be commissioned.

B. Pre-functional/startup checklists are important to verify that the equipment and systems are installed, fully connected and ready to operate in accordance with contract documents. It ensures performance testing (in-depth system checkout) may proceed without unnecessary delays. The pre-functional/startup checklist for a given system must be successfully completed and approved prior to formal performance testing of equipment or subsystems of the given system.

C. 3PCx will coordinate with Contractor and subcontractors for the commissioned equipment/system to create a pre-functional/startup checklist that is specific to the particular equipment/system. The intent of the pre-function/startup checklist is to incorporate the manufacturer's startup routines and 3PCx's initial checkout and startup requirements.

D. 3PCx will approve the final content and documentation format for all pre-functional/startup checklists used for commissioned equipment/systems on this project.

E. Contractor shall determine which trade is responsible for executing and documenting each of the line item tasks and transmit the checklist to the responsible subcontractors. Each form may have more than one trade responsible for its execution.

F. Contractor and subcontractors are to provide the services of personnel to implement the pre-functional/startup checklists.

G. Contractor is to provide access to contract plans, shop drawings, equipment cut sheets, control

system schematics, narrative description of control sequences of operation, as-built wiring schematics, sub-system interfaces and interlocks.

H. Execution of Pre-functional/Startup Checklists:

1. Six weeks prior to the scheduled startup, Contractor shall coordinate startup and checkout with Owner, Architect/Engineer and 3PCx. The execution of pre- functional/startup checklists, startup, and checkout shall be directed and performed on 100 percent of the equipment/systems by the personnel of the Contractor, subcontractors and/or equipment suppliers. Signatures are required of personnel performing pre-
2. functional/startup checklist tasks for verification of completion of their work.
3. Owner and Architect/Engineer, as necessary, shall observe execution of pre-functional/startup checklists.
4. 3PCx will observe execution of pre-functional/startup checklists based on sampling strategy identified in the commissioning plan.
5. The personnel of Contractor, subcontractors, and equipment suppliers shall execute startup and Contractor shall provide 3PCx with a signed and dated copy of completed pre-functional/startup checklists.
6. Only personnel of Contractor (technicians, engineers, tradesmen, equipment suppliers, etc.) who have direct knowledge and witnessed that a line item task on pre- functional/startup checklist was actually performed shall check off that item. It is not acceptable for witnessing supervisors to fill out these forms.
7. 3PCx will review and approve pre-functional/startup checklists submitted by Contractor.

I. Sample pre-functional/startup checklists are made a part of the project specifications.

J. Pre-functional/startup checklists filled out by the appropriate personnel, signed and approved by 3PCx will be included in the commissioning report.

3.5 3PCX WITNESSED FUNCTIONAL PERFORMANCE TESTING

A. 3PCx will provide test scripts to be used for 3PCx-witnessed testing.

B. 3PCx will be on site and execute functional performance testing to be witnessed by 3PCx.

C. Execution of 3PCx-Witnessed Functional Performance Testing:

1. 3PCx-witnessed functional performance testing will not proceed until Contractor-directed functional testing has been completed, forms have been completed and signed by the appropriate personnel, and 3PCx has reviewed and approved the test forms.
2. 3PCx shall coordinate with Owner and Architect/Engineer that Contractor-directed testing has been approved by 3PCx.
3. Contractor shall notify contracting team that 3PCx witness testing can proceed and that scheduling of 3PCx-witnessed testing should occur.
4. 3PCx-witnessed testing shall occur no sooner than 48 hours from approval of 3PCx
5. approval of Contractor-directed functional performance testing.
6. In some cases, multiple identical pieces of equipment will be witness tested by 3PCx using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates the common identity. A small size or capacity difference alone does not constitute a difference.
7. 3PCx-witnessed testing will occur when enough equipment/systems have met 3PCx
8. approval of Contractor-directed functional performance testing and can be grouped
9. together to be efficient for 3PCx to be on site.
10. During 3PCx-witnessed testing the contracting team executing/performing the mechanical/integrated automations systems test will execute the functional performance test which includes, at minimum:

a. Set the system equipment into the operating mode to be tested (i.e. normal shut-down, normal auto position, normal manual position, unoccupied cycle, emergency power and alarm conditions etc.).
b. Repeat test for each operating cycle that applies to the system being tested.
c. Perform operating checks of all safety cutouts, alarms, and interlocks with life safety and smoke control (if applicable) systems during all modes of operation of the mechanical/electrical systems.

11. During 3PCx-witnessed testing, the Contractor team executing/performing the fire suppression systems test will execute the functional performance test which includes, at minimum:

a. Set the zone into the test mode (i.e. each clean agent system is fully disarmed, pre-action sprinkler valve is closed, etc.).
b. Perform a functional test of devices (manual release stations, abort stations, smoke detectors, keyed maintenance switch, etc.) and compare each result against the Sequence of Operations Matrix as supplied by Architect/Engineer.
c. Repeat test for each zone that applies.
d. Perform operating checks of all signals sent to monitoring facilities and interlocks with smoke control and HVAC systems during all modes of operation of the fire suppression systems.

12. 3PCx shall inspect and verify the position of each device and interlock identified in the test procedure. Each item shall be signed off as acceptable (yes) or failed (no).
13. During 3PCx-witnessed functional testing, 3PCx will document results of the test on the functional performance test forms.
14. If during the test an operating deficiency is observed, appropriate comments will be added to the test procedure form and the issue log.
15. Corrections of minor deficiencies identified may be made during the tests at the discretion of 3PCx. In such cases the deficiency and resolution will be documented on the procedure form or an attached sheet.

D. Non-Conformance.

1. As tests progress and a deficiency is identified, 3PCx shall discuss the issue with commissioning team and Contractor.
2. When there is no dispute on the deficiency and Contractor accepts responsibility to correct it:

a. 3PCx will document the deficiency and Contractor's response and intentions. 3PCx will submit the non-compliance reports to Owner. Contractor corrects the deficiency, signs the statement of correction at the bottom of the non- compliance form certifying that the equipment is ready to be retested and sends it back to 3PCx.
b. Contractor shall reschedule the test, and the test shall be repeated.

3. If there is a dispute about a deficiency, regarding whether or not it is a deficiency:

a. The dispute shall be documented on the non-compliance form with the Contractor's response.
b. Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with Architect/Engineer. Final acceptance authority is with Owner.
c. 3PCx documents the resolution process.
d. Once the interpretation and resolution have been decided, Contractor corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to 3PCx. Contractor shall reschedule the test and the test is repeated until satisfactory performance is achieved.

4. Cost of retesting a performance test shall be paid by Contractor.
5. Contractor shall submit in writing to Owner and 3PCx at least as often as commissioning meetings are being scheduled the status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.

    a. 3PCx retains the original non-conformance forms until end of the project.
    b. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by Contractor.

E. Failure Due to Manufacturing Defect: If 10 percent (or three (3), whichever is greater) of identical pieces of equipment fail to perform to the contract documents (mechanically or substantively) due to a manufacturing defect not allowing it to meet its submitted performance specification, all identical units may be considered unacceptable by Architect/Engineer or 3PCx. In such case, Contractor shall provide Owner with the following:

1. Within one week of notification from Owner, Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to Owner within two weeks of the original notice.
2. Within two weeks of the original notification, Contractor or manufacturer shall provide a signed and dated written explanation of the problem, cause of failures, etc., and all proposed solutions. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
3. Architect/Engineer will determine whether a replacement of all identical units or a repair is acceptable.
4. Two examples, where applicable, of the proposed solution shall be installed by Contractor and Architect/Engineer shall be allowed to test the installations for up to one week, upon which Architect/Engineer will decide whether to accept the solution.
5. Upon acceptance, Contractor and/or manufacturer shall replace or repair all identical items at their expense. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

3.6 DEFERRED TESTING

A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the project completion level, required occupancy condition or other reason execution of checklists and performance testing may be delayed upon approval of Owner and 3PCx. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

B. Seasonal Testing: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. 3PCx shall coordinate this activity through Owner. Tests will be executed by the contracting team and will follow the steps of pre-functional/startup checklists, Contractor-directed functional testing,

and 3PCx-witnessed testing. Any final adjustments to the O&M manuals and as-built drawings due to testing shall be made by Contractor.

3.7 ELECTRICAL PREREQUISITES

A. A circuit breaker coordination study must be complete with all breakers set in accordance with the study, and a copy of the report transmitted to the commissioning Provider a minimum of two weeks prior to functional testing.

B. All electrical equipment shall have basic testing by the 3PTV electrical test agency prior to energizing any portion of the system in accordance with the National Electrical Testing Association's "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems".

3.8 LOAD BANK REQUIREMENTS

A. Generators: Sufficient resistive load banks shall be provided in order to apply 100 percent rated load to each of the generators during functional testing. House load bank may be used if available during commissioning.

B. All required load banks of the correct size (kW/kVA), voltage, discharge type, with cable of sufficient size and length, prior to start of FPTs and IST.

3.9 TYPES OF LOAD BANKS

A. It is important to remember that this document is outlining a specific load in a specific location and that larger sized load banks may not reduce the total number of load banks required. It is also important to note that load banks are normally rated for a certain load at given voltage. Since the behavior of resistive load banks requires that the amount of load drawn will decrease as the voltage decreases and this needs to be taken into account when figuring out exactly how many load banks and cables will be required.

B. All load banks to be placed indoors need to be side discharge or have hoods installed to convert them into side discharge. Top discharge load banks will not be allowed for any indoor use.

3.10 RECORD DOCUMENTS

A. Contractor shall maintain at the site one (1) record copy of all drawings, specifications, addenda, approved shop drawings, change orders, and other modifications in good order and marked to record all changes applicable to the work made during construction. All changes from design made during construction shall be recorded by Contractor. Contractor shall be responsible for sufficient detail and accuracy of all changes made.

B. Contractor record documents will be periodically reviewed and verified during construction by 3PCx. Discrepancies in the record documents will be documented in site visit reports and Contractor shall be responsible to verify and correct the record documents against the installed system for specified and all similar problems noted.

C. Contractor shall supply a draft copy of complete record documents to Architect/Engineer and Owner prior to initial training session.

3.11 EXCLUSIONS

A. Responsibility for Construction Means and Methods: 3PCx is not responsible for construction means, methods, job safety, or any construction management functions on the job site.

B. Hands-On Work by Commissioning Provider: Contractor shall provide all services requiring tools or the use of tools to startup, test, adjust, or otherwise bring equipment and systems into a fully operational state. 3PCx shall coordinate and observe these procedures (and may make minor adjustments), but shall not perform construction or technician services other than verification of testing, adjusting, balancing, and control functions.

END OF SECTION 01 9113

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Form liners.
3. Insulating concrete forms.
4. Shoring, bracing, and anchoring.

1.3 DEFINITIONS

A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Form Liners: Store form liners under cover to protect from sunlight.

B. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

a. Plywood, metal, or other approved panel materials.
b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
1) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces without spiral or vertical seams not exceeding specified formwork surface class.

1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

2.3 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:
1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

    a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings.

    a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 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 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.
4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
5. Clean embedded items immediately prior to concrete placement.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 FIELD QUALITY CONTROL

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

B. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Mechanical splice couplers.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

1.4 QUALITY ASSURANCE

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

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1. Store reinforcement to avoid contact with earth.
2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

2.2 GENERAL REINFORCING STEEL

A. To reduce the embodied carbon emissions for reinforcing steel bars at the previously stated ASTM standards and grades, provide reinforcing steel bars that shall not exceed the achievable Global Warming Potential (GWP) values, per state (contiguous United States) in the following table:

B. Table: Regional Summary for Rebar

State or Territory	Achievable GWP (KgCO2e/Kg)	Nearby State with Lowest Achievable GWP
Alabama	0.659	AL
Alaska	N/A	No min requirement
Arizona	0.598	AZ
Arkansas	0.686	Likely sourced from TN (CMC)
California	0.598	AZ
Colorado	0.650	CO
Connecticut	0.575	NY
Delaware	0.575	NY
Florida	0.789	FL
Georgia	0.614	SC
Hawaii	N/A	No min requirement
Idaho	0.413	WA
Illinois	0.718	IL
Indiana	0.686	TN
Iowa	0.718	IL
Kansas	0.650	CO
Kentucky	0.686	TN

Louisiana	0.713	TX
Maine	0.575	NY, may cost extra for shipping
Maryland	0.575	NY
Massachusetts	0.575	NY
Michigan	0.718	IL
Minnesota	0.718	IL
Mississippi	0.659	AL
Missouri	0.686	TN
Montana	0.413	WA
Nebraska	0.650	CO
Nevada	0.598	AZ
New Hampshire	0.575	NY
New Jersey	0.575	NY
New Mexico	0.598	AZ
New York	0.575	NY
North Carolina	0.614	SC
North Dakota	0.650	CO, may cost extra for shipping
Ohio	0.575	NY
Oklahoma	0.725	OK
Oregon	0.413	WA
Pennsylvania	0.575	NY
Rhode Island	0.575	NY
South Carolina	0.614	SC
South Dakota	0.650	CO
Tennessee	0.686	TX
Texas	0.713	TX
Utah	0.650	CO
Vermont	0.575	NY
Virginia	0.686	TN
Washington	0.413	WA
West Virginia	0.686	TN
Wisconsin	0.718	IL
Wyoming	0.650	CO

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

C. Mechanical Splice Couplers: ACI 318, same material of reinforcing bar being spliced.

D. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain.

2.4 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

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

B. Inspections:

1. Steel-reinforcement placement.
2. Steel-reinforcement mechanical splice couplers.
3. Steel-reinforcement welding.

END OF SECTION 032000

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 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.
B. American Association of State Highway and Transportation Officials (AASHTO):

1. Standard Specification For Transportation Materials And Methods Of Sampling and Testing:

a. AASHTO T318 - Water Content of Freshly Mixed Concrete Using Microwave Oven Drying (Formerly AASHTO TP 23).

C. American Concrete Institute (ACI):

1. ACI 117 - Tolerances for Concrete Construction and Materials and Commentary.
2. ACI 301 - Structural Concrete.
3. ACI 305.1 - Hot Weather Concreting.
4. ACI 306.1 - Cold Weather Concreting.
5. ACI 347 - Formwork for Concrete.
6. ACI SP66 - ACI Detailing Manual.

D. ASTM International (ASTM):

1. ASTM A 36 - Carbon Structural Steel.
2. ASTM A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. ASTM A 706 - Low-Alloy Steel deformed and Plain Bars for Concrete Reinforcement.
4. ASTM C 31 - Making and Curing Concrete Test Specimens in the Field.
5. ASTM C 33 - Concrete Aggregates.
6. ASTM C 39 - Concrete Specimens, Compressive Strength of.
7. ASTM C 42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
8. ASTM C 94 - Ready-Mixed Concrete.
9. ASTM C 138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
10. ASTM C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
11. ASTM C 150 - Portland Cement.
12. ASTM C 171 - Sheet Materials for Curing Concrete.
13. ASTM C 172 – Sampling Freshly Mixed Concrete.
14. ASTM C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
15. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
16. ASTM C 403 - Time of Setting of Concrete Mixtures by Penetration Resistance.
17. ASTM C 494 - Chemical Admixtures for Concrete.

18. ASTM C 618 - Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.
19. ASTM C 881 - Epoxy-Resin-Base Bonding Systems for Concrete.
20. ASTM C 989 - Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
21. ASTM C 1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
22. ASTM C 1218 - Water-Soluble Chloride in Mortar and Concrete.
23. ASTM C 1602 - Mixing Water used in the Production of Hydraulic Cement Concrete.
24. ASTM D 98 - Calcium Chloride.
25. ASTM D 448 - Classification for Sizes of Aggregate for Road and Bridge Construction.
26. ASTM D 698 - Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb (2.49 Kg) Hammer and 12-in (305 mm) Drop.
27. ASTM D 1241 - Materials for Soil-Aggregate Subbase, Base and Surface Courses
28. ASTM E 1155 - Determining Floor Flatness and Levelness Using the F-Number System (Inch-Pound Units).
29. ASTM E 1643 - Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
30. ASTM E 1745 - Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

E. American Welding Society (AWS):

1. AWS D1.4 - Structural Welding Code Reinforcing Steel.

F. Concrete Reinforcing Steel Institute (CRSI):

1. CRSI Manual of Standard Practice.
2. CRSI Placing Reinforcing Bars.

G. National Ready-Mixed Concrete Association:

1. NRMCA Inspection Standards.

H. Occupational Safety and Health Administration (OSHA):

1. OSHA 01926.1153 Respirable Crystalline Silica.

1.3 SUMMARY

A. Section Includes:

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

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners and insulating concrete forms.
3. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.

1.4 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.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following that apply.

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:
9. Vapor retarders.
10. Floor and slab treatments.
11. Liquid floor treatments.
12. Curing materials.
13. Joint fillers.
14. 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. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Intended placement method.
11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
12. Environmental Product Declaration

C. Shop Drawings:

1. Slab Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

    a. Location of construction joints is subject to approval of the Architect.

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.

E. Environmental Product Declaration (EPD):
1. Provide an Environmental Product Declaration identifying the global warming potential (GWP) for each mix design, or one EPD that includes all mix designs used in the project scope. The EPD(s) is/are to meet the requirements of Section 01 3329 - Sustainable Design Reporting, Part 4 - Scope 3 Carbon Emissions Tracking. The Global Warming Potential (GWP) of each mix design shall not exceed the limits identified in the below table "Maximum GWP Limits for Concrete Mix Designs." Suppliers are encouraged to provide mixes with GWP values that do not exceed the Preferred GWP values, provided all performance requirements identified in Appendix 03 3000 - Cast-in-Place Concrete are met to the satisfaction of the Engineer.
2. Table: Maximum GWP limits for Concrete Mix Designs

Mix Design Application	Min. Design Strength (psi)	Maximum Allowed GWP for Concrete Mix (kg CO2e per yd3)	Preferred GWP * (kg CO2e per yd3)
Exterior Pavement	4000	220	205
Exterior Walks and Curbs	4500	245	217
Foundations	3000	179	179
Interior slabs-on-ground	4000	220	205

a. Based on Federal Government recommendations to lower concrete embodied carbon 20% from current industry average, available at https://www.gsa.gov/system/files/Low%20embodied%20carbon%20concrete%20SOW%20language-Sept%202022.pdf

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 when used in Project, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.

C. Material Test Reports: For the following when used in Project, from a qualified testing agency:

1. Portland cement.
2. Blended hydraulic cement.
3. Fly ash.
4. Slag cement.
5. Silica fume.

6. Aggregates.

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

1. For continuous areas of cast in place concrete which exceed 1,000 SF

E. Preconstruction Test Reports: For each mix design.

F. Field quality-control reports.

G. 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.

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 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.

d. Seven-day compressive strength.
e. 28-day compressive strength.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.10 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 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 for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
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, 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 and ACI 305.1, and as follows:

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

1.11 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: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Normal Portland Cement:
   a. ASTM C150/C150M, Type I, Type II, Type I/II, or Type V, gray.
   b. ASTM C595, Type IL, gray.

2. Fly Ash: ASTM C618, Class C or F, except loss on ignition to be 6 percent maximum unless otherwise approved by Engineer.

3. Ground-Granulated-Blast-Furnace Slag (GGBFS) Cement: ASTM C989/C989M, Grade 100 or 120.

4. Silica Fume: ASTM C1240 amorphous silica.

5. Blended Hydraulic Cement: ASTM C595/C595M. Type IL, IP.IS, or IT Portland-limestone cement.

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

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. 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. Admixtures must meet the following ASTM standards:

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.

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

2.3 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: Provide a minimum 10-mil vapor retarder in accordance with ASTM E1745 equal to Stego, Fortifiber, or Viper, Class A under all slabs-on-ground. Provide a 15-mil vapor retarder if GC chooses to tail-gate the concrete, unless directed otherwise by the Geotechnical Engineer. Seams shall be lapped and taped using manufacturer approved tape and adhesive.

2.4 FLOOR AND SLAB TREATMENTS

A. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

2.5 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.6 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 : Black.
   b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
   c. Ambient Temperature Above 85 deg F: 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. Curing and Sealing Compound: Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B. Certified by curing compound manufacturer to not interfere with bonding of floor covering.

2.7 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 and class to suit requirements, and as follows:

1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.8 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 4100 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 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.9 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.

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

2. Not all mixes in the specification may be required. Refer to construction documents and provide only mixes that apply to the specific project requirements.

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 Fly Ash or other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass
5. Total Fly Ash or other Pozzolans and Silica Fume: 35 percent by mass.
6. Fly ash and slag shall not be permitted in concrete mix for interior slab work except where concrete is in contact with soils having severe or very severe sulfate content and Type V cement is not readily available, or to mitigate concrete against potential aggregate activity.

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

1. Use water-reducing high-range water-reducing or plasticizing 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.

D. Carbon dioxide injection:

a. If the batching plant is licensed with CarbonCure, and the addition of CO2 injection does not add cost, Carbon dioxide shall be injected into the concrete mixer, unless otherwise specified by the Engineer.
b. GC to communicate to owner if carbon dioxide injection is not available from selected vendor.
c. Inject carbon dioxide directly into the concrete mixer at the dosage and time recommended by the product supplier.
d. Dosage rate shall not exceed 4 fl oz. of carbon dioxide per hundred pounds of cement, or maximum dosage recommended by the carbon dioxide supplier, whichever is less.
e. Submit trial batching records showing reduction in cement content with the use of carbon injection at the submitted carbon dioxide dosage.

2.10 CONCRETE MIXTURES

A. Concrete Mix Requirements:

1. Normal-weight concrete.
2. Minimum Compressive Strength at 28 days: As noted on drawings.
3. Maximum water/cement ratio: As noted on drawings.
4. Slump Limit: Design slump at point of placement shall not exceed 6 inches and shall be of a consistency to be worked readily into forms and around reinforcement without segregation, voids, or excessive bleeding. Maximum slump variance shall be ±1.5 inches.
5. Air Content: As noted on drawings.
   a. Less than 3 percent when air entrainment is not used.
   b. 5.0 percent, plus or minus 1.5 percent at point of placement for concrete containing 3/4-inch nominal maximum aggregate size
   c. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

B. Lean Concrete (slurry) Mix Requirements

1. Minimum two sacks (188 lbs) of cementitious material per cubic yard.
2. Minimum 100 psi compressive strength (f'c) at 28 days
3. No air entrainment; less than 3% entrapped air content

2.11 CONCRETE MIXING

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

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. Daily access to the Work.

2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test 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.

3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.

a. Continue reinforcement across construction joints unless otherwise indicated.
b. Do not continue reinforcement through sides of strip placements of floors and slabs.

3. Space vertical joints in walls as indicated on drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.

4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.6 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, 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.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.
3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

a. Do not use vibrators to transport concrete inside forms.
b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
b. Remove projections larger than 1 inch.
c. Tie holes do not require patching.
d. Surface Tolerance: ACI 117 Class D.
e. Apply to concrete surfaces not exposed to public view.

2. ACI 301 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 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.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

    a. Slabs on Ground:

        1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft. long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch and also no more than1/16 inch in 2 feet.
        2) Specified overall values of flatness, F_F 50; and of levelness, F_L 35; with minimum local values of flatness, F_F 35; and of levelness, F_L 25.

C. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. 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.

3.10 CONCRETE CURING

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

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305.1, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 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.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:

a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12-inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) 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.

3) 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 Penetrating Liquid Floor Treatments: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) 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.

3) 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.

c. Floors to Receive Urethane Flooring:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

d. Floors to Receive Curing Compound:

1) Apply uniformly in 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) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer[unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project].

e. 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.

3.11 TOLERANCES

A. Conform to ACI 117.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than seven days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.13 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] [six] month(s).
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.

3.14 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.

3.15 FIELD QUALITY CONTROL

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

1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency shall report results of tests and inspections, in writing, to Owner, 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.

B. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

C. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

D. 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.

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 and below or 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C31/C31M:

a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

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

a. Test one laboratory-cured specimen at seven days, two specimens at 28 days and hold one specimen in reserve for later testing if required.
b. 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.

7. 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.
8. 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.
9. 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, section 1.6.6.3.

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

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

3.16 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 033060 - SPECIAL CONCRETE FLOOR FINISHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a water-based sodium silicate solution (and joint filler) used to densify, seal, and dustproof concrete.

B. Related Requirements:

1. Section 016116 “Volatile Organic Compound (VOC) Restrictions
2. Section 033000 – Cast In Place Concrete.

1.2 REFERENCES

A. Work in this section shall comply with the following:

1. American Society for Testing And Materials:

a. ASTM-C779, Standard Test Method for Abrasion Resistance Of Horizontal Concrete Surfaces.
b. ASTM-C805 – Impact Test Method
c. ASTM G23-81, Ultraviolet Light & Water Spray

2. American Concrete Institute:

a. 302. 1 R-89, Guide for Concrete Floor and Slab Construction.
b. Other test: reflectivity increase up to 30%.

1.3 SUBMITTALS

A. Closeout Submittals: Maintenance Data for inclusion in maintenance manual required by Division 01.

1. Include manufacturer’s instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use.
2. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.4 QUALITY ASSURANCE

A. Installer qualifications

1. A qualified firm, approved by the manufacturer, that has performed installation of a concrete floor finish system on at least 3 grocery retail stores of similar size and scope.
2. A qualified firm that is current on the latest application means and methods of special concrete floor finish and is eligible to receive manufacturer’s special warranty.

B. Manufacturer's certification:

1. Provide letter of certification from concrete finish manufacturer stating that installer is certified applicator of special concrete finishes, and is familiar with proper procedures and installation requirements required by the manufacturer.
2. Manufacturer certificate: indicating products listed on contractor's product list are compatible and suitable for the specified application.
3. Manufacturer: ISO 9001 quality certified as primary manufacturer of specified products.

C. Mock ups:

1. Apply mock ups of each type finish, to demonstrate typical joints, surface finish, color variation (if any), and standard of workmanship.
2. Build mock-ups approximately 100 square feet in the location indicated or if not indicated, as directed by the architect.
3. Notify architect or tenant representative seven days in advance of dates and times when mock-ups will be constructed.
4. Obtain from the tenant representative approval of mock-ups before starting installation.
5. Maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed work.

D. Pre installation conference:

1. Coordinate meeting with Section 033000 requirements.

2. No satisfactory chemical or cleaning procedure is available to remove petroleum stains from the concrete surface. Prevention is therefore essential:
   a. All hydraulic powered equipment must be diapered to avoid staining of the concrete.
   b. No trade will park vehicles on the inside slab. If necessary to complete their scope of work, drop cloths will be placed under vehicles at all times.
   c. No pipe cutting machine will be used on any floor slab scheduled to receive special concrete floor finish.
   d. Steel will not be placed on interior slab to avoid rust staining.
   e. Acids and acidic detergents shall not come into contact with slab.
   f. Inform all trades that the concrete floor slab must be protected at all times.
   g. Equip lifts with non-marking tires.
   h. Provide spill kit as recommended by product manufacturer. Contractor to have spill kit on site in 4 locations during duration of construction for quick spill cleaning.

1.5 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer. Maintain record of container numbers.

B. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Prevent product from freezing.

D. Protect materials during handling and application to prevent damage or contamination.

1.6 PROJECT CONDITIONS

A. General:

1. Close spaces to traffic during special concrete floor finish system application.

B. Environmental limitations

1. Comply with manufacturers written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting topping performance.

C. Grinding operations: Initial grinding operation shall commence 7 days after initial pour. Contractor shall perform final grinding operations thirty (30) days after initial grind. Contractor shall provide floor protection covering to allow full construction operations between grinding operations.

1. Control and collect dust produced by grinding operations. Protect adjacent construction from detrimental effects of grinding operations.
2. Provide dustproof partitions and temporary enclosures to limit dust migration and to isolate areas from noise.
3. Concrete floor levelness rating recommended at 30.
4. Concrete floor flatness rating recommended at 30.
5. Wet grind floor procedure:

a. metal bonds: 16,30,70,120
b. resin bond grits: 50, 100, 200, 400

D. Concrete must be cured a minimum of 45 days or as directed by the manufacturer before application of the finish system can begin. Contractor shall provide floor protection to allow continuing construction operations after initial grinding and prior to finish applications.

E. Contractor shall perform a final cleaning 10 days prior to substantial completion as coordinated with superintendent and owner’s representative.

F. Do not apply product when air, surface, or material temperatures are expected to fall below 40" F. Within 4 hours of expected application.

G. Prior to application, verify floor slabs are free of construction latents.

H. Close areas to traffic during floor application and for 8 hours after application.

1.7 WARRANTY

A. Special warranty for special concrete floor finish:

1. Provide 20 year manufacturer's material warranty for all components of the system commencing at date of building substantial completion.
2. 5 year manufacturer's labor warranty commencing at date of building substantial completion.

PART 2 - PRODUCTS

2.1 LIQUID DENSIFIER

A. General: Penetrating concrete densifier odorless, colorless, VOC - compliant, non-yellowing sodium silicate solution designed to harden, dustproof and protect concrete floors.

B. Manufacturers:

1. Euclid, Euclid Chemical Co., Euclid, OH; www.euclidchemical.com.

A. Eucosil (Basis of Design)

2. Advanced Floor Products (Division of Cure Crete Distribution, Inc.)

A. RetroPlate Concrete Polishing System

3. Laticrete

A. L&M Lion Hard

4. Dayton Superior

A. Pentra-Hard Densifier

2.2 ACCESSORIES

1. Concrete grinding system of diamond grinding in graduated grits.

a. Level 3 finish.

2. Penetrating stain repellant:

a. As recommended by manufacturer of Liquid Floor Treatment.

1) Apply per manufacturer's written instructions.

3. Semi-rigid polyurea joint filler:

a. Ashford Crete-Fill as manufactured by Curecrete Distribution Company, Inc.
b. Color: match adjacent exposed concrete.

1) Apply anti-staining film to prevent penetration of joint filler amine, scrub clean upon completion.

PART 3 - EXECUTION

3.1 GENERAL:

A. Comply with manufacturers written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting special concrete floor finish system performance.

3.2 SURFACE CONDITIONS

A. Examine substrate, with installer present, for conditions affecting performance of finish. Correct conditions detrimental to timely and proper work. Do not proceed until unsatisfactory conditions are corrected.

B. Ensure surfaces are clean, dry and free of standing water.

C. Remove dirt, dust, oil, grease, sealers, and other materials that may prevent penetration of liquid densifier sealer.

D. Verify that base slab meets finish and surface profile requirements.

3.3 APPLICATION:

A. Apply liquid densifier sealer to designated concrete areas in continuous manner following manufacturer’s published recommendations regarding coverage and installation. Brush out all puddles and runs immediately. Do not allow excess material to dry on surface.

B. Manufacturer's field service:

1. Engage a factory-authorized service representative to inspect the substrate before application of stain repellent and to instruct applicator on the product and application method to be used. Comply with manufacturers written application instructions.

3.4 WORKMANSHIP AND CLEANING

A. Remove spatter from adjoining surfaces, as necessary.

B. Repair damages to surface caused by cleaning operations.

C. Protect finished work until fully cured in accordance with manufacturer's recommendations.

END OF SECTION 033060

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SECTION 033061 – SEALED CONCRETE FLOOR FINISHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a solvent based curing and sealing compound and slip resistant additive applied to concrete floor surfaces.

1.2 RELATED SECTIONS

A. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.3 SUBMITTALS

A. Closeout Submittals: Maintenance Data for inclusion in maintenance manual required by Division 01.

1. Include manufacturer’s instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use.
2. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels.

B. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

1.5 PROJECT CONDITIONS

A. Environmental requirements: do not proceed with installation until areas to receive the work have been enclosed and until temperature and relative humidity have been stabilized and will be maintained within values established by the manufacturer for optimum quality control.

B. Ventilation: provide adequate ventilation to prevent accumulation of hazardous fumes, if any, during application of concrete floor sealer in enclosed spaces, and maintain ventilation until sealer has cured.

PART 2 - PRODUCT

2.1 CURING AND SEALING COMPOUND

A. Concrete curing and sealing compound. A ready-to-use, acrylic curing and sealing compound for use on new and existing, interior and exterior, horizontal and vertical concrete surfaces. Product shall conform to:

B. ASTM C 309, T 1 class A & B and ASTM C 1315 type 1 class A.

C. AASHTO specification M 148, type 1, class A & B

1. Product: Euclid Chemical Company (The); Diamond Clear, www.euclidchemical.com

D. Manufacturer shall have ISO 9001 quality certification.

E. Substitutions: Reference section 012500 – Substitution Procedures

PART 3 - EXECUTION

3.1 EXAMINATION

A. When used on existing concrete, examine concrete surfaces to receive curing and sealing compound. Notify specifier if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions are corrected.

3.2 SURFACE PREPARATION

A. When used on existing concrete, prepare concrete surfaces in accordance with manufacturer's written instructions.

B. Ensure surfaces are clean and free of standing water.

C. Remove dirt, dust, oil, grease, sealers, and other materials that may prevent adhesion of curing and sealing compound.

D. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.3 APPLICATION

A. For the best cure, apply diamond clear as soon as possible after finishing operations and/or immediately after the disappearance of the "sheen" of surface moisture.

B. Apply curing and sealing compound in uniform coverage rate to concrete surfaces in accordance with manufacturer's written instructions.

C. Apply as soon as possible after finishing and immediately after disappearance of surface moisture sheen, when used to cure freshly placed concrete.

D. Do not apply to concrete to receive toppings, epoxy coatings, urethane coatings, or epoxy adhesives.

E. Do not use as a bond breaker for tilt-up construction.

F. Do not dilute curing and sealing compound.

G. Cure concrete surfaces as specified in Section 033000.

END OF SECTION 033061

SECTION 034713 - TILT-UP CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes load-bearing, tilt-up concrete, including the following:

1. Monolithic panels.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for additional concrete requirements.
2. Section 031000 "Concrete Forming and Accessories" for forms and accessories.
3. Section 032000 "Concrete Reinforcement" for reinforcement.
4. Section 076200 "Sheet Metal Flashing and Trim" for flashing receivers and reglets.

1.2 DEFINITIONS

A. Face-down Surface: Concealed surface of as-cast, tilt-up panel formed against the casting slab.

B. Face-up Surface: Exposed upper surface of as-cast, tilt-up panel.

C. Reveal: Projection of the coarse aggregate from the matrix after exposure.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the project site.

1. Before submitting design mixes, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with tilt-up 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. Tilt-up concrete Subcontractor.

2. Review special inspection procedures; testing and inspecting agency procedures for field quality control; tilt-up concrete finishes and finishing; cold- and hot-weather concreting procedures; curing procedures; casting-slab construction, flatness and levelness, finish, and joint requirements; steel reinforcement installation; hoisting and erection plans; measurement of fabrication and erection tolerances; tilt-up concrete repair procedures; and tilt-up concrete protection.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

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. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Intended placement method.
11. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
12. Environmental Product Declaration.

C. Shop Drawings: Detail fabrication and installation of tilt-up concrete units. Indicate panel locations, plans, elevations, dimensions, shapes, cross sections, and details of steel embedments. Match panel identification designations on Shop Drawings with those on Contract Drawings.

1. Include steel reinforcement, detailing fabrication, bending, and placing. Include material, grade, bar schedules, stirrup spacing, bent-bar diagrams, arrangement, and supports of concrete reinforcement.
2. Include additional steel reinforcement to resist hoisting and erection stresses.
3. Include locations and details of hoisting points and lifting devices for handling and erection.
4. Include engineering analysis data of additional steel reinforcement and hoisting and erection details, signed and sealed by the qualified professional engineer responsible for their preparation.
5. Indicate welded connections by AWS standard symbols. Detail cast-in inserts, connections, and joints, including accessories.
6. Include layout of wythe connectors for sandwich panels.

D. Environmental Product Declaration (EPD):
1. Provide an Environmental Product Declaration identifying the global warming potential (GWP) for each mix design, or one EPD that includes all mix designs used in the project scope. The EPD(s) is/are to meet the requirements of Section 01 3329 - Sustainable Design Reporting, Part 4 - Scope 3 Carbon Emissions Tracking. The Global Warming Potential (GWP) of each mix design shall not exceed the limits identified in the below table “Maximum GWP Limits for Concrete Mix Designs.” Suppliers are encouraged to provide mixes with GWP values that do not exceed the Preferred GWP values, provided all performance requirements identified in Appendix 03 3000 - Cast-in-Place Concrete are met to the satisfaction of the Engineer.

2. Table: Maximum GWP limits for Concrete Mix Designs

Mix Design Application	Min. Design Strength (psi)	Maximum Allowed GWP for Concrete Mix (kg CO2e per yd3)	Preferred GWP * (kg CO2e per yd3)
Tilt-up walls	4000	220	205

a. Based on Federal Government recommendations to lower concrete embodied carbon 20% from current industry average, available at https://www.gsa.gov/system/files/Low%20embodied%20carbon%20concrete%20SOW%20language-Sept%202022.pdf

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer, testing agency.

B. Welding certificates.

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

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Bond breakers.
5. Curing compounds.
6. Inserts and embedments.

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

1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. 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 according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Installer Qualifications: A qualified installer who employs a supervisor on Project who is an ACI-certified Tilt-up Supervisor.

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests to be qualified as ACI Concrete Field Testing Technician, Grade I, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency

laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.
2. AWS D1.4/D1.4M.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete mixtures.

PART 2 - PRODUCTS

2.1 TILT-UP CONCRETE, GENERAL

A. Comply with ACI 301, unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. pNormal Portland Cement:
   a. ASTM C150/C150M, Type I, Type II, Type I/II, or Type V, gray.
   b. ASTM C595, Type IL, gray.

2. Fly Ash: ASTM C618, Class C or F, except loss on ignition to be 3 percent maximum unless otherwise approved by Engineer.

3. Ground-Granulated-Blast-Furnace Slag (GGBFS) Cement: ASTM C989/C989M, Grade 100 or 120.

4. Silica Fume: ASTM C1240 amorphous silica.

5. Blended Hydraulic Cement: ASTM C595/C595M. Type IL, IP.IS, or IT Portland-limestone cement.

C. Coarse Aggregate: ASTM C33/C33M, Class 4S coarse aggregate or better, graded. Provide aggregates from single source.

1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.

D. Fine Aggregate: ASTM C33/C33M or ASTM C144, manufactured or natural sand, from same source for Project, free of materials with deleterious reactivity to alkali in cement.

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

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and 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.

G. Water: ASTM C94/C94M**,** potable.

2.3 BOND BREAKERS

A. Solvent-Borne, Chemically Reactive Bond Breaker: Penetrating polymerized solution containing no oils, waxes, paraffins, or silicones, and compatible with casting-slab curing compound.

B. Solvent-Borne, Membrane-Forming Bond Breaker: Dissipating polymerized solution containing no oils, waxes, paraffins, or silicones, and compatible with casting-slab curing compound.

C. Waterborne, Chemically Reactive Bond Breaker: Penetrating polymerized emulsion containing no oils, waxes, paraffins, or silicones, and compatible with casting-slab curing compound.

D. Waterborne, Membrane-Forming Bond Breaker: Dissipating polymerized emulsion containing no oils, waxes, paraffins, or silicones, and compatible with casting-slab curing compound.

2.4 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. (305 g/sq. m) when dry.

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

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

2.5 CONNECTION MATERIALS

A. Embedded Metal Items and Loose Hardware: Comply with Section 055000 "Metal Fabrications" for materials for securing tilt-up concrete panels together and to supporting and adjacent construction.

B. Loose Hardware: Comply with Section 055000 "Metal Fabrications" for materials for securing tilt-up concrete panels together and to supporting and adjacent construction.

C. Carbon-Steel Shapes and Plates: ASTM A36/A36M.

D. Carbon-Steel Bolts and Studs: ASTM A307, Grade A (ASTM F568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.

E. Unheaded Carbon-Steel Rods and Nuts: ASTM A36/A36M, threaded rods with ASTM A563, nuts.

F. Welded Headed Studs: AWS D1.1/D1.1M, Type B headed studs, and cold-finished, carbon-steel bars.

G. Low-Alloy-Steel Reinforcing Bars: ASTM A706/A706M, deformed.

H. Chord Bar Sleeves: Tubular sheathing, plastic or moisture-resistance-treated cardboard.

I. Welding Electrodes: Comply with AWS standards.

J. Hot-Dip Galvanized Finish: Apply zinc coating to steel connections by hot-dip process, complying with ASTM A123/A123M or ASTM A153/A153M as applicable.

1. Zinc Repair Paint: SSPC-Paint 20.

K. Shop-Primed Finish: Prepare surfaces of steel connections, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop-apply primer according to SSPC-PA 1.

2.6 LIFTING INSERTS AND ACCESSORIES

A. Furnish inserts, dowels, bolts, nuts, washers, and other items to be cast in panels for tilting and lifting.

1. Manufacture inserts with feet of plastic, galvanized-steel wire, plastic-tipped steel wire, or stainless steel-tipped steel wire.

B. Furnish brace anchors and other accessories to be cast in panels and in casting slab for attaching bracing.

1. Manufacture wall brace anchors and accessories with feet of galvanized-steel wire, plastic-tipped steel wire, or stainless steel-tipped steel wire.
2. Manufacture floor brace anchors that do not penetrate vapor retarder under slab-on-grade.

2.7 BEARING PADS

A. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet; Type A Shore durometer hardness of 50 to 70, ASTM D2240; and minimum tensile strength of 2250 psi (15.5 MPa), ASTM D412.

B. Random, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer with a Type A Shore durometer hardness of 70 to 90, ASTM D2240.

C. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded in elastomer with a Type A Shore durometer hardness of 80 to 100, ASTM D2240.

D. High-Density Plastic Strips: Multimonomer, nonleaching plastic.

2.8 GROUT

A. Cement Grout: Portland cement, ASTM C150/C150M, Type I or II, and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents; complying with ASTM C1107, of consistency suitable for application.

2.9 MISCELLANEOUS MATERIALS

A. Flashing Reglets: Open type having continuous groove not less than 1-1/8 inches (28 mm) deep by 3/16 inch (5 mm) wide at opening and sloped upward to 45 degrees. Temporarily fill or cover face openings of reglets to prevent intrusion of concrete or debris.

1. Stainless Steel: ASTM A240/A240M, Type 304, soft annealed, not less than 0.0187 inch (0.5 mm) thick.
2. Copper Strip: ASTM B370, Temper H00 or O60, not less than 16 oz./sq. ft. (0.55 mm thick).
3. Hot-Dip Galvanized-Steel Sheet: ASTM A653/A653M, G90 (Z275) coating, not less than 0.0217 inch (0.55 mm) thick.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.0336 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.10 REPAIR MATERIALS

A. Bonding Agent: ASTM C1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

B. Patching Mortar: Dry-pack mix consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

2.11 CONCRETE MIXTURES

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures for each type and strength of concrete, proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures based on laboratory trial mixtures.

C. 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 Fly Ash or other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass
5. Total Fly Ash or other Pozzolans and Silica Fume: 35 percent by mass

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

1. Use water-reducing high-range water-reducing or plasticizing 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.

E. Carbon dioxide injection:
   a. If the batching plant is licensed with CarbonCure, and the addition of CO2 injection does not add cost, Carbon dioxide shall be injected into the concrete mixer, unless otherwise specified by the Engineer.
   b. GC to communicate to owner if carbon dioxide injection is not available from selected vendor.
   c. Inject carbon dioxide directly into the concrete mixer at the dosage and time recommended by the product supplier.
   d. Dosage rate shall not exceed 4 fl oz. of carbon dioxide per hundred pounds of cement, or maximum dosage recommended by the carbon dioxide supplier, whichever is less.
   e. Submit trial batching records showing reduction in cement content with the use of carbon injection at the submitted carbon dioxide dosage.

F. Normal-weight concrete used for exterior tilt-up wall panels:

1. Minimum Compressive Strength: 4000 psi at 28 days, unless noted otherwise on drawings.
2. Maximum w/cm: 0.50.
3. Slump Limit: 4 inches, plus or minus 1.5 inches at point of delivery.
4. Air Content: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size.
5. Supplementary Cementitious Materials:
   a. As a minimum, the mix must contain either:
      1) Class C or F fly ash at a dosage of at least 15 percent by weight of cementitious material, or
      2) Slag cement at a dosage of at least 20 percent by weight of cementitious material.
   b. Fly ash, natural pozzolan, and slag cement contents refer to all fly ash, natural pozzolan, and slag cement in the mix, regardless of whether the material is part of a blended cement or added to the cement prior to mixing.

G. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.

1. When air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Construct and brace formwork so tilt-up concrete panels are of size, shape, alignment, elevation, and position indicated.

1. Construct forms on slab-on-grade or on temporary casting slab, at Contractor's option.
2. Provide for openings, offsets, recesses, reveals, rustications, reglets, and blockouts.
3. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concreting. Coat form liner with form-release agent.

B. Construct forms for easy removal without hammering or prying against concrete surfaces. Use kerfed inserts, such as those forming reglets, rustications, and recesses, for easy removal.

C. Set edge forms for panels to achieve required panel thickness.

D. Chamfer exposed corners and edges, unless otherwise indicated, using chamfer strips fabricated to produce uniform, smooth lines and tight edge joints.

E. Coat contact surfaces of wood forms and chamfers with sealer before placing reinforcement.

3.2 BOND BREAKER INSTALLATION

A. Uniformly and continuously apply two coats of bond breaker to casting-slab surfaces by power spray or roller according to manufacturer's written instructions, before placing steel reinforcement. Recoat areas subjected to moisture before drying. Maintain continuity of coating until concrete placement.

B. After placing steel reinforcement, touch up or recoat worn or damaged areas with bond breaker. Do not splash or coat steel reinforcement and inserts.

3.3 REINFORCEMENT AND INSERT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating and placing reinforcement.

B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover.

1. Field weld reinforcement according to AWS D1.4/D1.4M, where indicated.
2. Do not tack-weld crossing reinforcing bars.
3. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

C. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

D. Accurately place and securely support embedded items, anchorages, inserts, cramps, retainers, bar chords and sleeves, and other items to be built into panels. Coordinate with other trades for installing cast-in items.

3.4 PANEL CASTING, GENERAL

A. Comply with ACI 301 (ACI 301M) for handling, placing, and consolidating concrete.

B. Maintain position of steel reinforcement, inserts, and anchors during concrete placement, consolidation, and finishing.

C. Screed panel surfaces to correct level with a straightedge and strike off.

1. Begin initial floating before excess moisture or bleedwater appears on the surface. Use bull floats or darbies to form a uniform and open-textured surface plane free of humps or hollows. Do not disturb panel surfaces before beginning finishing operations.

D. Form chamfers at top edges of panel perimeters, openings, and similar locations not formed by chamfer strips unless otherwise indicated.

E. Surface Defects: Limit visible surface defects to those permitted by TCA's "Tilt-up Concrete Association's Guideline Specifications" for Grade B, Standard panel surfaces.

3.5 CASTING TOLERANCES

A. Cast tilt-up concrete panels without exceeding the following tolerances:

1. Height and Width of Panels:

   a. For Panels up to 20 Feet (6.1 m) Tall: 1/4 inch (6 mm) wide.
   b. For Panels 20 to 30 Feet (6.1 to 9.1 m) Tall: 3/8 inch (10 mm) wide.
   c. Each Additional 10 Feet (3.05 m) in Excess of 30 Feet (9.1 m) Tall: 1/8 inch (3 mm) wide.

2. Thickness: 3/16 inch (5 mm).
3. Skew of Panel or Opening: Difference in length of diagonals of 1/8 inch per 72 inches (3 mm per 1830 mm) with a maximum difference of 1/2 inch (13 mm).
4. Openings Cast into Panel:

   a. Size of Opening: 1/4 inch (6 mm).
   b. Location of Centerline of Opening: 1/4 inch (6 mm).

5. Location and Placement of Embedded Items:

   a. Inserts, Bolts, and Pipe Sleeves: 3/8 inch (10 mm).
   b. Lifting and Bracing Inserts: As required by manufacturer.
   c. Lateral Placement of Weld Plate Embedments: 1 inch (25 mm).
   d. Tipping and Flushness of Weld Plate Embedments: 1/4 inch (6 mm).

6. Deviation of Steel Reinforcement Cover: Maintain minimum cover required by ACI 301 (ACI 301M).

3.6 FACE-UP FINISHES

A. Float Finish: Consolidate surface of plastic concrete with power-driven floats or by hand floating. Restraighten and cut down high spots and fill low spots. Repeat float passes and restraighten until surface is left with a uniform, smooth, granular texture.

B. Trowel Finish: After applying float finish, apply first trowel finish and consolidate plastic concrete by hand trowel or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and is uniform in texture and appearance.

C. Trowel and Fine-Broom Finish: After applying float finish, apply a partial trowel finish to plastic concrete, stopping after second troweling. Immediately after second troweling, and when concrete is still plastic, slightly scarify the surface with a fine broom.

3.7 FACE-DOWN FINISHES

A. Smooth, As-Cast Finish: Cast panel to produce a surface free of pockets, sand streaks, and honeycombs. Produce a surface appearance of uniform color and texture.

B. Form-Liner Finish: Cast panel over form liners placed, secured, and sealed over casting slab to produce a textured surface free of pockets, streaks, and honeycombs. Produce a surface appearance of uniform color and texture.

3.8 CONCRETE PROTECTING AND CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures according to ACI 301 (ACI 301M).

1. Apply evaporation retarder in hot, dry, or windy weather to protect concrete from rapid moisture loss before and during finishing operations. Apply according to manufacturer's written instructions after screeding and bull floating concrete, but before float finishing.

B. Begin curing immediately after finishing concrete. Cure by one or a combination of the following methods according to ACI 308.1:

1. Moisture Curing: Keep surfaces continuously moist for no fewer than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. 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 (300 mm), and sealed by waterproof tape or adhesive. Cure for no fewer than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 ERECTION

A. Use erection equipment with care to prevent damage to floor slabs and panels.

B. Erect panels from building exterior.

C. Lift, support, and erect panels only at designated lifting or supporting points indicated on Shop Drawings.

D. Do not erect panels until 75 percent of 28-day compressive strength of concrete has been verified.

E. Install tilt-up concrete panels level, plumb, square, and true. Place panels on leveled grout-setting pads or shims in correct position. Maintain joint width of 3/4 inch (19 mm) between panels.

1. Install tilt-up concrete panels with face-down surfaces exposed to exterior of building.

F. Temporarily brace and support panels securely in position against loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to panels are secured.

G. Anchor panels in place and, if indicated, to one another.

1. Weld steel connectors to steel supports and embedments indicated, complying with AWS D1.1/D1.1M.

H. Solidly grout-fill gaps between foundation system and bottom of panels.

3.10 FIELD QUALITY CONTROL

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

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before erection of tilt-up panels.

C. Testing Services: Tests to be performed according to ACI 301 (ACI 301M).

D. Tilt-up concrete panels will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 ERECTION TOLERANCES

A. Install tilt-up concrete panels without exceeding the following erection tolerances:

1. Joint Width Variation (Exterior Face): Without decreasing or increasing more than 50 percent from specified joint width, maintain joint width as follows:

a. For Panels up to 20 Feet (6.1 m) Tall: 1/4 inch (6 mm).
b. Each Additional 10 Feet (3.05 m) in Excess of 20 Feet (6.1 m) Tall: 1/8 inch (3 mm).

2. Joint Taper: Maximum 3/8 inch (10 mm) over length, but not greater than the following:

    a. For Panels up to 20 Feet (6.1 m) Tall: 1/4 inch (6 mm).
    b. Each Additional 10 Feet (3.05 m) in Excess of 20 Feet (6.1 m) Tall: 1/8 inch (3 mm).

3. Panel Alignment:

    a. Alignment of Horizontal and Vertical Joints: 1/4 inch (6 mm).
    b. Offset in Exterior Face of Adjacent Panels: 1/4 inch (6 mm).

3.12 FILLING AND REPAIR

A. Patch holes and voids left by erecting and bracing inserts on tilt-up panels and slabs-on-grade. Cut or chip edges of voids perpendicular to concrete surface. Fill blockouts where indicated.

1. Clean, dampen with water, and brush-coat holes, voids, and blockouts with bonding agent. Fill and compact with patching mortar of a stiff consistency before bonding agent has dried.
2. Finish surfaces of fills and repairs to Architect's approval, with materials of same colors and textures as finishes on surrounding surfaces.

B. Repair damaged galvanized-steel surfaces of connectors by cleaning and applying a coat of zinc repair paint.

C. Repair damage to tilt-up panels and slabs-on-grade resulting from tilt-up work, as directed by Architect.

D. Remove and replace tilt-up panels that do not comply with requirements in this Section.

E. Demolish and remove temporary concrete casting slabs.

END OF SECTION 034713

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

B. Related Requirements:

1. 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.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 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.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

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.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

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, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Shop primers.
3. Nonshrink grout.

F. Survey of existing conditions.

G. Source quality-control reports.

H. Field quality-control and special inspection reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

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

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

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

1. AISC 303.
2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.7 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 Owner's 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 F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M.

B. Channels, Angles, M , S-Shapes: ASTM A 36/A 36M.

C. Plate and Bar: ASTM A 36/A 36M.

D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade C; or ASTM 1085, structural tubing.

E. Corrosion-Resisting, Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.

F. Steel Pipe: ASTM A 53/A 53M, Type E or Type S, Grade B.

G. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. Headed Anchor Rods: ASTM F 1554, Grade 36, straight, unless noted otherwise on drawings.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436, Type 1, hardened carbon steel.
4. Finish: Plain.

C. Threaded Rods: ASTM A 36/A 36M

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel.
3. Finish: Plain.

2.3 SHOP PRIMER

A. Provide shop primer that complies with Section 099000 "Painting and Coating."

B. Interior Framing: Minimum SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

1. Color: Manufacturer's standard.

C. Exterior Framing: Minimum SSPC-Paint 20, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 20.

1. Color: Manufacturer's standard.

2.4 GROUT

A. Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, mixed with water to consistency suitable for application and a 30-minute working time; compressive strength of 5000 psi in 28 days.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

1. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
2. Mark and match-mark materials for field assembly.
3. 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, or punch standard bolt holes perpendicular to metal surfaces.

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

E. 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.

2.6 SHOP CONNECTIONS

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

2.7 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.
2. Galvanized surfaces.

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

1. SSPC-SP 2, "Hand Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to 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.

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

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. Galvanized items:

    a. Structural steel angles and embed plates permanently exposed to weather and in contact with or embedded in concrete or masonry.
    b. Anchor bolts permanently exposed to weather and in contact with or embedded in concrete or masonry.
    c. As indicated on Drawings.

2.9 SOURCE QUALITY CONTROL

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

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M.

C. 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.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and 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. Snug-tighten 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 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 shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

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.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection.

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 according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

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

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified 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.

C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

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 and priming as specified in Section 09.00.00 – Paints and Coatings

END OF SECTION 051200

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SECTION 052100 - STEEL JOIST 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. K-series steel joists.
2. KCS-type K-series steel joists.
3. K-series steel joist substitutes.
4. Steel joist girders.
5. Steel joist accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
2. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.3 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Welding certificates.

C. Manufacturer certificates.

D. Mill Certificates: For each type of bolt.

E. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation, including drawings and calculations.

F. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.8 SEQUENCING

A. Deliver steel bearing plates to be built into cast-in-place concrete and masonry construction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.

1. Use ASD; data are given at service-load level or use LRFD; data are given as unfactored-load level.
2. Design special joists to withstand design loads with live-load deflections no greater than the following:
   a. Roof Joists: Vertical deflection of 1/240 of the span.

2.2 STEEL JOISTS

A. K-Series Steel Joist: Manufactured steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: K-series steel joists and KCS-type K-series steel joists.
2. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
3. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated on Drawings, complying with SJI's "Specifications."
4. Camber joists according to SJI's "Specifications."
5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.3 STEEL JOIST GIRDERS

A. Manufactured joist girders according to "Standard Specification for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements as indicated on Drawings.
   1. Top-Chord Arrangement: Parallel
   2. Camber joist girders according to SJI's "Specifications."
   3. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

2.4 SHOP PRIMERS

A. Provide shop primer that complies with Section 099000 "Painting and Coating."

B. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
   1. Color: Manufacturer's standard.

2.5 STEEL JOIST ACCESSORIES

A. Bridging:

   1. Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
   2. Schematically indicated. Detail and fabricate according to SJI's "Specifications Furnish additional erection bridging if required for stability.

B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings.

C. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."

D. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.

   1. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated on Drawings.
   2. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

E. High-Strength 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.

   1. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

F. Welding Electrodes: Comply with AWS standards.

G. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

H. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts unless noted otherwise.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Touchup Painting:

1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.

    a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
    b. Apply a compatible primer of same type as primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in Section 099000 "Painting and Coating."

3.4 FIELD QUALITY CONTROL

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

B. Visually inspect field welds according to AWS D1.1/D1.1M.

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

a. Liquid Penetrant Inspection: ASTM E165/E165M.
b. Magnetic Particle Inspection: ASTM E709.
c. Ultrasonic Testing: ASTM E164.
d. Radiographic Testing: ASTM E94.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports.

END OF SECTION 052100

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SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.
2. Noncomposite form deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.
2. Noncomposite form deck.

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.

1.3 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Welding certificates.
2. Product Certificates: For each type of steel deck.

B. Test and Evaluation Reports:

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

    a. Power-actuated mechanical fasteners.

2. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:

a. AWS D1.1/D1.1M.
b. AWS D1.3/D1.3M.

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

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 listings of another qualified testing agency.

2.2 METAL DECK

A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
1. Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), Grade 50 minimum
2. Deck Profile: As indicated on the structural drawings.
3. Profile Depth: As indicated on the structural drawings.
4. Design Uncoated-Steel Thickness: As indicated on the structural drawings.
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped.
7. Ends Laps: Overlapped.
8. Shop Finish: Cleaned and pretreated surface primed with manufacturer's standard baked-on, rust-inhibitive primer:
a. Top Color: Manufacturer's standard grey or white.
b. Bottom Color: Manufacturer's standard white.

B. Canopy Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
1. Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), Grade 50 minimum
2. Deck Profile: As indicated on the structural drawings.
3. Profile Depth: As indicated on the structural drawings.
4. Design Uncoated-Steel Thickness: As indicated on the structural drawings.

5. Span Condition: Triple span or more.
6. Side Laps: Overlapped.
7. Ends Laps: Overlapped with top sheet up the slope.
8. Shop Finish: Cleaned and pretreated surface primed with manufacturer's standard baked-on, rust-inhibitive primer:
   a. Top Color: Manufacturer's standard white.
   b. Bottom Color: Manufacturer's standard white.
9. Field Finish: As indicated on the arch drawings.

2.3 ACCESSORIES

A. 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 (4.8-mm) minimum diameter.

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

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 50 ksi, not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 50 ksi of same material and finish as deck, and of thickness and profile recommended by SDI standards 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. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch (1.90 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.

I. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

J. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and [level] [sloped] recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.

K. Galvanizing Repair Paint: ASTM A780/A780M.

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; 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 in accordance with deck manufacturer's written instructions.

J. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

A. Fasten roof-deck panels to steel supporting members as indicated on drawings.

B. Side-Lap Fastening: Fasten side laps of panels between supports, as indicated on the drawings and as follows:

1. Mechanically fasten with self-drilling, self-tapping No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped 2 inches (50 mm) minimum.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.

1. Mechanically fasten cover plates at changes in direction of roof-deck panels unless otherwise indicated.

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

F. Metal Canopy Deck
1. Install panels such that panel joint occurs at top of rib.
2. Coordinate with work of other Sections to produce watertight assembly, capable of withstanding loading pressures and thermal and lateral loads.
3. Install gutter and downspouts furnished under other Sections.
4. Lap panels, set into sealant, and fasten at spacing indicated on drawings.
5. Isolate metals from dissimilar metals or corrosive substrates using bituminous coating.
6. Fill space between metal panel and support beam and between metal panel and light fixtures with pre-molded closure accessory strip to eliminate nesting space for birds.
7. Field Finish: Paint canopy supports, structural steel, metal fabrications and accessories on tops, bottoms, edges and other weather exposed surfaces as indicated on Drawings, in accordance with Section 099000

3.4 REPAIR

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

B. Repair Painting:

1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099000 "Painting and Coating."

3.5 FIELD QUALITY CONTROL

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

B. Tests and Inspections:

1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.

a. Field welds will be subject to inspection.

2. Steel decking will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the construction of all heavy gauge (structural steel stud) framing assemblies including studs, braces, channels, sills, headers, load bearing wall framing, roof framing, ceiling framing, and miscellaneous metal parts, paints, and tests.:

B. Related Requirements:
   1. Section 016116 “Volatile Organic Compound (VOC) Restrictions
   2. Section 055000 “Metal Fabrications”
   3. Section 092216 “Non-Structural Metal Framing”

1.3 ACTION SUBMITTALS – NOT USED

1.4 INFORMATIONAL SUBMITTALS – NOT USED

1.5 QUALITY ASSURANCE

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

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   1. ClarkDietrich.
   2. MBA Building Supplies.
   3. SCAFCO Steel Stud Company.

4. The Steel Network, Inc.

2.2 COLD-FORMED STEEL FRAMING MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated.

B. Steel Sheet for Clips: ASTM A653/A653M, structural steel, zinc coated.

2.3 COLD-FORM STEEL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, as indicated on drawings.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, as indicated on drawings.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, as indicated on drawings.

D. Vertical Deflection Clips: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

E. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, as indicated on drawings.

F. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges, as indicated on drawings.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure.

2. Inner Track: Of web depth indicated.

G. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

H. Steel Joists: Manufacturer's standard C-shaped steel joists, of web depths indicated, unpunched or punched with standard holes, with stiffened flanges, as indicated on drawings.

I. Steel Joist Track: Manufacturer's standard U-shaped steel joist track, of web depths indicated, unpunched, with unstiffened flanges, as indicated on drawings.

J. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, as indicated on drawings.

2.4 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.5 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated.

C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, as appropriate for the substrate.

D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction.

E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780/A780M.

B. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.

C. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

D. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch (6 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

E. Sill Sealer Gasket/Termite Barrier: Minimum 68-mil (1.7-mm) nominal thickness, self-adhering sheet consisting of 64 mils (1.6 mm) of rubberized asphalt laminated on one side to a 4-mil- (0.10-mm-) thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of Section 016116 and authorities having jurisdiction.

1. Physical Properties:

a. Peel Adhesion: 17.0 lb/in of width (2.9 N/mm of width) when tested in accordance with ASTM D412.
b. Low-Temperature Flexibility: Pass at minus 25 deg F (minus 32 deg C) when tested in accordance with)ASTM D146/D146M.
c. Water Vapor Permeance: 0.05 perm (0.44 ng/Pa x s x sq. m) maximum when tested in accordance with ASTM E96/E96M, Method B.
d. Resistance to Termite Penetration: Comply with ICC-ES AC380.

2.7 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Where indicated on the Drawings, before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sill sealer gasket/termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF LOAD-BEARING WALL FRAMING

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and as indicated on drawings.

B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch (3 mm) between the end of wall-framing member and the web of track.

1. Fasten both flanges of studs to top and bottom tracks.
2. Space studs as follows:

a. Stud Spacing: As indicated on Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically as indicated on Drawings. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION OF EXTERIOR NONLOADBEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated on Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to studs and anchor to building structure.
4. Connect drift clips to cold-formed steel framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on drawings but not more than 72 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within **12 inches (305 mm)** of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at centers indicated on drawings.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INSTALLATION OF INTERIOR NONLOADBEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated on drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to studs and anchor to building structure.
4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on drawings but not more than 72 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within **12 inches (305 mm)** of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

1. Install solid blocking at centers indicated on drawings.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.7 INSTALLATION OF JOIST FRAMING

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Space joists not more than 2 inches (51 mm) from abutting walls, and as follows:

1. Joist Spacing: As indicated on drawings.

D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.

1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated on drawings. Fasten bridging at each joist intersection as follows:

1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.8 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.9 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for countertops.
3. Steel tube reinforcement for low partitions.
4. Steel framing and supports for mechanical, electrical and refrigeration equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
6. Shelf angles.
7. Metal ladders.
8. Structural-steel door frames.

B. Products furnished, but not installed, under this Section include the following:

1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 051200 – “Structural Steel Framing”
2. Section 054000 – “Cold Formed Metal Framing”
3. Section 055119 – “Metal Grating Stairs”
4. Section 055213 – “Pipe Tube and Railing”

1.3 COORDINATION

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

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. 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.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufactured metal ladders.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for countertops.
3. Steel tube reinforcement for low partitions.
4. Steel framing and supports for mechanical, electrical and refrigeration equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
6. Shelf angles.
7. Metal ladders.
8. Structural-steel door frames.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

B. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

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

E. Research Reports: For post-installed anchors.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

D. Rolled-Stainless Steel Floor Plate: ASTM A793.

E. Steel Tubing: ASTM A500/A500M, Grade C; or ASTM 1085, cold-formed steel tubing.

F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

F. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.3 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099900 “Paints and Coatings”

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications, with a minimum compressive strength of 5000 psi in 28 days.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, concrete with a minimum 28-day compressive strength as noted on drawings.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch

hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate steel pipe columns for supporting frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
2. Unless otherwise indicated, provide 1/2-inch baseplates with four 5/8-inch anchor bolts and 1/4-inch top plates.

D. Galvanize miscellaneous framing and supports where indicated.

E. Prime miscellaneous framing and supports with primer specified in Section 099900 "Paints and Coatings" where indicated.

2.6 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Prime shelf angles located in exterior walls with primer specified in Section 099900 "Paints and Coatings."

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.7 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.
2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails 18 inches apart unless otherwise indicated.
2. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
3. Rungs: 3/4-inch diameter steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 1/2 inch in least dimension.
9. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
10. Galvanize exterior ladders, including brackets.
11. Provide padlockable 72” ladder guard doors at base of fixed access ladders; color to be Safety Yellow.
12. Prime exterior ladders, including brackets and fasteners, with primer specified in Section 099000 - "Paints and Coatings".

2.8 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Prime steel frames with primer specified in Section 099900 "Paints and Coatings."

2.9 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Prime miscellaneous steel trim with primer specified in Section 099900 "Paints and Coatings."

2.10 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.11 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.12 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized, unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primer specified in Section 099900 "Paints and Coatings."

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.13 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

C. Anchor shelf angles securely to existing construction with expansion anchors, anchor bolts, through bolts per details or manufacturer recommendations.

3.3 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09.90.00 - Paints and Coatings.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

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SECTION 055119 - METAL GRATING STAIRS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stairs with metal treads.
2. Stairs with grating treads.
3. Structural steel stair framing and supports.
4. Handrails and guards.

B. Related Requirements:

1. Section 055000 – "Metal Fabrications."
2. Section 099000 – "Painting and Coating"

1.2 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel

B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

E. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

F. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength (Metric)

G. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

H. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

I. ASTM A786/A786M - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates

J. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

K. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

L. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2012

M. AWS D1.1/D1.1M - Structural Welding Code - Steel

N. NAAMM AMP 510 - Metal Stairs Manual

O. OSHA-CFR 1910.23 and 1926 - Guarding Floor and Wall Openings

P. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer

Q. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic")

R. SSPC-SP 2 - Hand Tool Cleaning

1.3 DESIGN REQUIREMENTS

A. Design and fabricate stair assembly to support a uniform live load of 100 lb/sq ft and a concentrated load of 300 lb on an area of 4 square inches, with deflection of stringer or landing framing not to exceed 1/180 of span.

B. Engineer, fabricate, and install handrails and railing systems to withstand the following structural loads:

1. Top Rail of Guardrail: Uniform load of 50 pounds per linear foot applied in any direction at the top, and a concentrated load of 200 pounds applied in any direction at any point along the top. The concentrated and uniform loads need not be assumed to act concurrently.
2. Infill Area of Guardrail: Horizontal load of 50 pounds on an area not to exceed 1 square foot, including openings and space between rails. This load need not be assumed to act concurrently with loads on top rails of railing system in determining stress on guard.

1.4 SUBMITTALS

A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

1. Include the design engineer's stamp or seal on each sheet of shop drawings.

B. Welders' Certificates.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in producing steel stairs similar to those indicated for this Project with a record of successful in-service performance.

B. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.

C. Welder Qualifications: Show certification of welders employed on the Work, verifying AWS qualification within the previous 12 months.

PART 2 PRODUCTS

2.1 METAL STAIRS - GENERAL

A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.

1. Regulatory Requirements: Provide stairs and railings complying with the most stringent requirements of local, state, and federal regulations; where requirements of the contract documents exceed those of regulations, comply with the contract documents.

2. Structural Design: Provide complete stair and railing assemblies complying with the applicable local code.

B. Metal Jointing and Finish Quality Levels:

1. Commercial: Exposed joints as inconspicuous as possible, whether welded or mechanical; underside of stair not covered by soffit IS considered exposed to view.

a. Welded Joints: Intermittently welded on back side, filled with body putty, and sanded smooth and flush.
b. Welds Exposed to View: Ground smooth and flush.
c. Mechanical Joints: Butted tight, flush, and hairline.
d. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts.
e. Exposed Edges and Corners: Eased to small uniform radius.
f. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for satin or matte finish.

2.2 METAL STAIRS WITH GRATINGTREADS

A. Jointing and Finish Quality Level: Commercial, as defined above.

B. Risers: Closed.

C. Treads: Grip Strut Safety Grating, regular duty, with slip resistant serrated surface.

1. Galvanized Steel - hot-dip galvanized before fabrication, ASTM A525 (G-90) standard.
2. Height: 1-1/2 inches.
3. Gage: Minimum 12 gage or as required for span.

D. Stringers: Rolled steel channels.

1. Stringer Depth: 12inches.
2. End Closure: Sheet steel of same thickness as risers welded across ends.

E. Landings: Same construction as treads, supported and reinforced as required to achieve design loadcapacity.

F. Railings: Steel pipe railings.

G. Finish: Galvanized after fabrication.

2.3 HANDRAILS AND GUARDS

A. Handrails: Round pipe rails unless otherwiseindicated.

1. Nominal Diameter: 1-1/4inch.

B. Guards - Interior (Square):

1. Top Rails: Square tube rails unless otherwise indicated.

a. Nominal Dimension: 1 1/2 inch x 1 1/2 inch x 1/8 inch.

2. Infill at Pipe Railings: Square tube rails sloped parallel to stair.

    a. Nominal Dimension: 1 1/2 inch x 1 1/2 inch x 1/8 inch.
    b. Jointing: Welded and ground smooth and flush.

3. End and Intermediate Posts: Same material and size as top rails.

    a. Horizontal Spacing: As indicated on drawings.
    b. Mounting: Welded to top surface of stringer.

C. Guards - Exterior (Round):

1. Top Rails: Round pipe or tube rails unless otherwise indicated.

    a. Nominal Diameter: 2 inch.

2. Infill at Pipe Railings: Pipe or tube rails sloped parallel to stair.

    a. Pipe Nominal Diameter: 2 inch.
    b. Material: Steel pipe or tube, round.
    c. Jointing: Welded and ground smooth and flush.

3. End and Intermediate Posts: Same material and size as top rails.

    a. Horizontal Spacing: As indicated on drawings.
    b. Mounting: Welded to top surface of stringer.

D. Fabrication:

1. Fabricate pipe handrails and railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of pipe, post spacings, and anchorage, but not less than that required to support structural loads.

2. Interconnect railing and handrail members by butt welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

    a. At tee and cross intersections, cope ends of intersecting members to fit contour of pipe to which end is joined, and weld all around.

3. Form changes in direction of handrails and rails as follows:

    a. By welding in prefabricated flush elbow fittings.
    b. By radius bends of radius indicated.
    c. By flush radius bends.
    d. By bending.
    e. By any method indicated above, applicable to change of direction involved.

4. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.
5. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
6. Close exposed ends of pipe by welding 3/16-inch- (4.8-mm-) thick steel plate in place or with prefabricated fittings.
7. Locate drain or vent holes in pipe in inconspicuous locations. Plug all holes before delivery to site.

8. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnections of pipe and attachment of handrails and railing systems to other work. Furnish inserts and other anchorage devices for connecting handrails and railing systems to concrete or masonry work.

2.4 MATERIALS

A. Steel Sections: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.

C. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.

D. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.

1. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Designation CS (commercial steel).
2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel).

E. Checkered Plate: ASTM A786/A786M, rolled steel floor plate; pattern no. 2.

F. Safety Grating: Grip Strut Safety Grating, regular duty, with slip resistant serrated surface.

2.5 SHOP FINISHING

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Prime Painting: Use specified shop- and touch-up primer.

1. Preparation of Steel: In accordance with SSPC-SP 2, Hand Tool Cleaning.
2. Number of Coats: One, gray metal primer, or approved equal, applied to a minimum dry film thickness of 2.0 mils.

D. Galvanizing: Hot-dip galvanize to minimum requirements of ASTMA123/A123M.

1. Touch up abraded areas after fabrication using specified touch-up primer for galvanized surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.2 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.

B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.

C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.

E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.

F. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.

G. Obtain approval prior to site cutting or creating adjustments not scheduled.

H. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.3 INSTALLING STEEL PIPE RAILINGS AND HANDRAILS

A. Adjust handrails and railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:

1. Anchor posts to steel by welding directly to steel supporting members.
2. Anchor handrail ends into concrete and masonry with steel round flanges welded to rail ends and anchored into wall construction with drilled-in expansion anchors.

B. Secure handrails to wall with wall brackets and end fittings. Provide bracket with minimum 1-1/2 inch, or as required by code, clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets and wall return fittings to building construction as follows:

1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt or concrete and solid masonry anchorage, use drilled in expansion anchor.

3.4 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

3.5 SCHEDULES

A. Interior stairs and railings: Prime painted finish.

B. Exterior stairs and railings: Galvanized finish.

END OF SECTION 055119

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes steel pipe railings.

B. Related Requirements:

1. Section 060000 "Rough Carpentry" for wood blocking for anchoring railings.

1.2 SUBMITTALS

A. Product Data: For fasteners, anchors, grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Submit original documents prepared by fabricator. Copies of contract documents are unacceptable.

C. Welding certificates.

1.3 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.4 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.5 COORDINATION AND SCHEDULING

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 anchorages for railings. 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.

C. Schedule installation so wall attachments are made only to completed walls.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.2 STEEL AND IRON

A. HSS1.660x0.140 Hollow Structural Steel Tube: ASTM A 500 Grade B.

2.3 FASTENERS

A. General: Provide the following:

1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 for zinc coating.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors with accompanying ICC Evaluation Report indicating load capacity and appropriate use of each anchor.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for exterior locations: Hot dip galvanized carbon steel or stainless steel.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Section 09 91 23 "Interior Painting."

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage. Post spacing shall not exceed 4’-0”.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

F. Connections: Fabricate railings with welded connections unless otherwise indicated.

G. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

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 flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

H. Form changes in direction as follows:

1. By bending.

I. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

J. Close exposed ends of railing members with prefabricated end fittings.

K. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

L. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide approved wood blocking as required to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

M. Provide inserts if required and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.6 STEEL AND IRON FINISHES

A. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1 Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

A. For posts in concrete slabs on grade, form or core-drill holes to depth indicated on Drawings and 2 inches larger than OD of post for installing posts in concrete. Clean holes of loose material, install mechanical anchors, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Cover anchorage joint with flange of same metal as post, attached to post with set screws.

C. Anchor posts to plywood or metal surfaces through baseplate with screws or through bolts as indicated in drawings.

3.5 ATTACHING RAILINGS

A. Attach railings to wall with wall brackets. Provide brackets with clearance from inside face of handrail to finished wall surface as noted in drawings. Locate brackets at 4’-0” O.C. maximum spacing.

1. Use bracket with three-hole flange (two top, one bottom) capable of accepting ¼" diameter anchors.

B. Secure wall brackets and railing end flanges to building construction as follows:

1. For concrete and solid or hollow masonry anchorage, use ¼" diameter self-tapping concrete screws.

2. For existing steel-framed partitions with multiple layer gypsum board, use ¼" diameter toggle bolts. For new steel-framed partitions, use ¼" diameter sheet metal screws completely through fire-retardant-treated wood blocking between studs. Coordinate with stud installation to locate backing members. All fasteners in contact with treated wood blocking must be compatible with fire retardant treatment.

3.6 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

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SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheathing.
2. Concealed wood blocking, nailers, and supports.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions

2. Section 092116 - Gypsum Board Assemblies: Gypsum-Based Sheathing.

1.2 REFERENCE STANDARDS

A. AFPE (WFCM) - Wood Frame Construction Manual For One- And Two-Family Dwellings; American Forest And Paper Association; 2012.

B. ASTM A153/A153M - Standard Specification For Zinc Coating (Hot-Dip) On Iron And Steel Hardware; 2009.

C. ASTM C1396/C1396M - Standard Specification For Gypsum Board; 2014.

D. PS 1 - Structural Plywood; 2009.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Lumber fabricated from old growth timber is not permitted.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Sizes: nominal sizes as indicated on drawings, S4S.

B. Moisture content: S-dry or MC19.

C. Miscellaneous framing, blocking, nailers, grounds, and furring:

1. Lumber: S4S, no. 2 or standard grade.
2. Boards: standard or no. 3.

2.3 CONSTRUCTION PANELS

A. Wall sheathing: plywood, PS 1, grade C-D, exposure I.

B. Backer panels for electrical, data, communication panels (where indicated on drawings): Fire-Retardant-Treated (FRT) Plywood complying with ASTM E 84 flame spread testing. Grade C-D, exposure I.

C. Plywood Roof Wood Deck

1. Provide minimum ½" thick APA rated Struct-I Sheathing, designed in accordance with local building code and climate requirements. Roof insulation must be installed on the top side of deck – it will not be acceptable to install insulation on underside of wood deck. Also, a white scrim sheet shall be installed on the underside of wood panel roof joists.
2. Sheathing shall be 'FSC Certified' material sourcing.

D. Fastening Method

1. Sheathing shall be mechanically fastened (driven or screwed) to supporting structure.

2.4 ACCESSORIES

A. Fasteners and anchors:

1. Metal and finish: hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2. Drywall screws: bugle head, hardened steel, power driven type, length three times thickness of sheathing.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate installation of rough carpentry members specified in other sections.

3.2 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

3.3 FRAMING INSTALLATION

A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.

B. Install structural members full length without splices unless otherwise specifically detailed.

C. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AFPA wood frame construction manual.

D. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

3.4 BLOCKING, NAILERS, AND SUPPORTS

A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

B. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.

C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.

D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.

3.5 INSTALLATION OF CONSTRUCTION PANELS

A. Underlayment: Secure to subflooring with nails and glue.

1. At locations where resilient flooring will be installed, fill and sand splits, gaps, and rough areas.
2. Place building paper between floor underlayment and subflooring.

B. Wall sheathing: secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.

3.6 TOLERANCES

A. Framing members: 1/4 inch from true position, maximum.

B. Surface flatness of floor: 1/8 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

C. Variation from plane (other than floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

3.7 CLEANING

A. Waste disposal: comply with the requirements of section 01 74 19 - Construction Waste Management and Disposal.

B. Comply with applicable regulations.

1. Do not burn scrap on project site.
2. Do not burn scraps that have been pressure treated.
3. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

C. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

D. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 061000

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SECTION 062000 - FINISH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Finish carpentry items.
2. Wood casings and moldings.
3. Hardware and attachment accessories.

B. Related Requirements:

1. Section 061000 - Rough Carpentry: Support Framing, Grounds, and Concealed Blocking.
2. Section 099900 - Paints and Coatings

1.2 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics Of Building Materials; 2015A.

B. ASTM E 684 - Critical Radiant Flux of Floor Covering Systems.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with installation of associated and adjacent components.

PART 2 - PRODUCTS

2.1 FINISH CARPENTRY ITEMS

A. Surface burning characteristics: Provide materials having fire and smoke properties as required by applicable code.

B. Interior woodwork items:

1. Miscellaneous wall trim: Paint grade poplar.

2.2 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

2.3 FASTENINGS

A. Fasteners of size and type suitable for application.

2.4 ACCESSORIES

A. Wood filler: Solvent base, tinted to match surface finish color.

2.5 FABRICATION

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

B. Fit exposed sheet material edges with 3/8 inch matching hardwood edging. Use one piece for full length only.

C. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set and secure materials and components in place, plumb and level.

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

3.2 PREPARATION FOR SITE FINISHING

A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.

3.3 TOLERANCES

A. Maximum variation from true position: 1/16 inch.

B. Maximum offset from true alignment with abutting materials: 1/32 inch.

END OF SECTION 062000

SECTION 064100 - ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic laminate faced cabinets
2. Countertops
3. Wood mouldings and trim
4. Hardware and attachment accessories.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 061000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
3. Section 099000 – Paints and Coatings

1.2 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics Of Building Materials; 2015A.

B. ANSI A208.1 - American National Standard for Particleboard

C. ANSI A208.2 - American National Standard for Medium Density Fiberboard for Interior Use

D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards

E. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada

F. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association

G. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce)

1.3 QUALITY ASSURANCE

A. Perform work in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Custom quality, unless other quality is indicated for specific items.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect units and materials from moisture damage.

B. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 - PRODUCTS

2.1 CABINETS

A. Plastic laminate faced cabinets: Custom grade.

2.2 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

B. Composite wood products shall not contain any added urea-formaldehyde binder or resins (NAUF).

2.3 LUMBER MATERIALS

A. Softwood Lumber: NIST PS 20; Graded in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Grade III/Economy; average moisture content of 5- 10 percent.

1. Semi-Exposed Surfaces: Species – white pine, covered with plastic laminate.
2. Internal Construction: Species - white pine.

B. Interior Woodwork Items:

1. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI//AWMAC/WI Architectural Woodwork Standards for Custom Grade.
2. Moldings, Bases, Casings, and Miscellaneous Trim: Clear pine; prepare for stained finish.

2.4 PANEL MATERIALS

A. Particleboard: ANSI A208.1; medium density industrial type as specified in AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, composed of wood chips bonded with interior grade adhesive under heat and pressure; sanded faces; thickness as required; use for all components not indicated as another material.

B. Medium Density Fiberboard (MDF): ANSI A208.2; type as specified in AWI/AWMAC Architectural Woodwork Quality Standards Illustrated; composed of wood fibers pressure bonded with interior grade adhesive to suit application; sanded faces; thickness as required.

1. Use for painted components and components indicated on the drawings.
2. Use as backing for plastic laminate unless otherwise indicated.

C. Hardboard: AHA A135.4; Pressed wood fiber with resin binder, Class 1 - Tempered, 1/4 inch thick, smooth one side (S1S); use for gables and backs.

2.5 LAMINATE MATERIALS

A. Provide specific types as scheduled.

B. Manufacturer: As indicated on the Drawings.

C. Laminate adhesives used to fabricate on-site and shop applied composite wood and agrifiber assemblies must not contain added urea-formaldehyde resins.

D. Plastic Laminate: High pressure plastic laminate meeting or exceeding NEMA LD 3-1985 performance standards for high pressure decorative laminates as to resistance to wear, burns,

stains, moisture, water, and dimensional change for types and grade designations of plastic laminates indicated. Laminates shall be GREENGUARD for Indoor Air Quality Certified by the GREENGUARD Environmental Institute under the GREENGUARD Standard for Low Emitting Products.

1. General Purpose 50: Nominal 0.050-inch thick, for horizontal and high use exposure.
2. General Purpose 28: Nominal 0.028-inch thick, for vertical and medium use exposure.
3. Concealed Surfaces: Melamine, decolam, or approved equal low-pressure laminate UNO on drawings. Color: White.
4. PVC edge-banding will not be accepted unless it exactly matches cabinet face laminate in color, pattern, and texture. If PVC edge-banding to match is not available, provide plastic laminate edge-banding to match cabinet face. Plastic laminate edge-banding shall be applied prior to laminate on face of doors to minimize dark edges at laminate joints.

E. High pressure decorative laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

F. Color: As specified on the Drawings.

2.6 COUNTERTOPS

A. Provide specific types as scheduled.

B. Solid Surface Countertops:

1. Materials: Homogenous solid sheets of filled plastic resin complying with the material and performance requirements of ANSI Z124.3, Type 5 or 6, without a precoated finish.

a. Thickness: 3/4 inch nominal.

b. Color: as specified on the Drawings

C. Plastic laminate countertops:

1. Medium density fiberboard substrate covered with HPDL, conventionally fabricated and self-edge banded.

2. Color: as specified on the Drawings

2.7 ACCESSORIES

A. Adhesive: Type recommended by AWI/AWMAC to suit application.

1. Reference sections 016116 for VOC limitations.

B. Fasteners: Size and type to suit application.

C. Bolts, nuts, washers, lags, pins, and screws: of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.

D. Concealed Joint Fasteners: Threaded steel.

2.8 HARDWARE

A. See additional information on drawings.

B. All hardware to be commercial grade.

1. No substitutions allowed unless specifically noted.

C. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.

D. Cabinet locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.

E. Hinges: European style concealed self-closing type, steel with satin finish.

F. Adjustable Cabinet Shelf Supports: Standard side-mounted system using multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 3/4 inch (or 32mm) spacing adjustments.

G. Adjustable Shelving Supports: Heavy duty back-mounted system using surface mounted metal shelf standards and coordinated heavy duty cantilevered shelf brackets, satin chrome finish, for nominal 1 inch spacing adjustments. Include clips to screw shelf bracket to shelf.

1. Standards: #80/85 Anodized double slotted, steel 16 ga, manufactured by Knape-Vogt.

2. Brackets: #180/185 Anodized double slotted, 2 inch less than shelf depth, manufactured by Knape-Vogt.

H. Drawer and Door Pulls: "U" shaped wire pull, aluminum with satin finish, 4 inch centers.

1. Product: EPC-MC402-4-A manufactured by Epco.

I. Drawer Slides: Ball bearing type, rated for 100 lb. load, full extension.

1. Product: Accuride #3135EC Full Extension Undermount.

J. Hinges: European Style, open to 120 degrees, steel with satin finish. Provide restriction clips where doors or pulls area adjacent to perpendicular surfaces.

1. Product: Blum 170 ‘Clip Series’

K. Sliding Door Track Assemblies: Upper and lower track of satin anodized aluminum, with matching shoe equipped with nylon rollers.

L. Countertop Brace Mounting Bracket: 10 x 10 inch with diagonal braces, integral mounting holes and black matte finish.

M. Fixed Bracket (wall mounted): 18 x 18 inch with diagonal braces, integral mounting holes, and matte black finish.

1. Product: #SWS2 by Doug Mockett & Co.

N. Cable Access Grommets: Doug Mockett & Co.: Flip Top Series.

1. Standard painted metal or rubber grommets for cut-outs, in color to match adjacent surface.

2.9 FABRICATION

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

B. Plastic laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises.

C. Cabinet Style: Flush overlay.

D. Cabinet Doors and Drawer Fronts: Flush style.

E. Drawer boxes shall fill 95% of cavity and extend to no less than 2” from back of cabinet.

F. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

G. Mechanically fasten back splash to countertops with steel brackets at 16 inches on center.

H. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

I. Site Finishing: Site finished as required by Architect.

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 work of this section.

3.2 PREPARATION

A. AWI Standard: Comply with AWI Quality Standards, Section 1500, for sanding, filling countersunk fasteners, back priming and similar preparations for finishing of architectural woodwork, as applicable to each unit of work.

B. Conditioning: Condition woodwork to average prevailing humidity conditions for a minimum of seven (7) days in installation areas before installing.

C. Inserts: Deliver concrete inserts and similar anchoring devices to be built into substrates, well in advance of time substrates are to be built.

D. Examination of Woodwork: Before installation of architectural woodwork, examine shop fabricated work for completion, and complete work as required, including back priming and removal of packing.

3.3 INSTALLATION

A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level. Install to a tolerance of 1/8 inch in 8 feet for plumb and level (including countertops); and with 1/16 inch maximum offset in flush adjoining surfaces.

B. Use fixture attachments in concealed locations for wall mounted components.

C. Use concealed joint fasteners to align and secure adjoining cabinet units.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.

E. Secure cabinets to floor using appropriate angles and anchorages.

F. Standard and Running Trims:

1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns, miter at corners, and comply with AWI Quality Standards for joinery.

G. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.4 ADJUSTING

A. Adjust installed work.

B. Maximum clearance between doors or jambs and cabinet doors shall not exceed 1/16 inch.

C. Adjust moving or operating parts to function smoothly and correctly.

3.5 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 064100

SECTION 066400 - PLASTIC PANELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass-fiber reinforced plastic (FRP) wall paneling.
2. Unreinforced polypropylene paneling.
3. Molding, adhesives, and joint sealants.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 102601 - Wall End Protectors and Corner Guards

1.2 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.

2.2 PLASTIC SHEET PANELING

A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D 5319. Panels shall be USDA accepted for incidental food contact.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Crane Composites, Inc.,
      1) Fire-X Glasbord FM with Surfaseal
   b. Substitutions: As permitted in 012500.

2. Surface-Burning Characteristics: As follows when tested by a qualified testing agency according to ASTM E 84. Identify products with appropriate markings of applicable testing agency.

   1) Flame-Spread Index: 25 or less.
   2) Smoke-Developed Index: 450 or less.
   3) Fire Rating: Class A

3. Nominal Thickness: Not less than 0.09 inch.
4. Surface Finish: Smooth.
5. Color: #85 White.

B. Unreinforced polypropylene paneling: Solid polypropylene panels made from no less than 80 percent recycled material.

1. Nominal thickness: Not less than 0.09 inches.
2. Color: White.
3. Molding color: White.
4. Surface finish: Molded pebble texture.

2.3 ACCESSORIES

A. Trim accessories: manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.

1. Color: To match paneling

B. Adhesives: As recommended by plastic paneling manufacturer. Reference Section 016116 Volatile Organic Compound (VOC) Restrictions for VOC limitations.

C. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 07 92 00 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.

B. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.

C. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.

D. Lay out paneling before installing. Locate panel joints to provide equal panels at ends of walls not less than half the width of full panels.

1. Mark plumb lines on substrate at trim accessory locations for accurate installation.

2. Locate trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION - WALLS

A. Install panels in accordance with manufacturer's instructions.

B. Install panels in a full spread of adhesive.

C. Install trim accessories with adhesive and nails or staples. Do not fasten through panels.

D. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.

E. Maintain uniform space between panels and wall fixtures. Fill space with sealant.

F. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 066400

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SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Batt Insulation
2. Sound Attenuation Insulation (Sound Batts)
3. Board Insulation.

B. Related Requirements

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 075423 – Thermoplastic Polyolefin Roofing (TPO) for polyisocyanurate insulation.

1.2 REFERENCE STANDARDS

A. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

C. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials

D. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

E. ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.

1.3 DEFINITIONS

A. Concealed Insulation: Insulation concealed within framing system, both faces protected by finish material.

B. Exposed Insulation: Insulation exposed on face of existing walls or within framing system, one or both faces unprotected.

PART 2 - PRODUCTS

2.1 BATT INSULATION MATERIALS

A. Manufacturers: Provide by one of the following:

1. CertainTeed Corporation
2. Johns Manville
3. Owens Corning
4. Guardian Fiberglass, Inc.

B. Mineral fiber batt insulation: flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.

1. Smoke developed index: 0 (zero), when tested in accordance with ASTM E84.
2. Sound transmission class (STC): for interior partitions, entire assembly to achieve a minimum STC rating of 45
3. Minimum R Value: as indicated on drawings.

C. Unfaced Thermal Batt Insulation:

1. Type: Fiberglass insulation equal to Knauf Insulation EcoBatt Insulation, complying with ASTM C 665-84, Type 1, Class A.
2. Maximum flame spread 25.
3. Maximum smoke developed 50.
4. Thickness: per wall type see drawings.
5. Minimum R Value: as indicated on drawings.

D. Foil Faced Thermal Batt Insulation:

1. Type: Fiberglass insulation equal to Knauf Insulation EcoBatt Insulation FSK-25, complying with ASTM C 665-84, Type III, Class A.
2. Maximum flame spread 25.
3. Maximum smoke developed 50.
4. Thickness: per wall type see drawings.
5. Minimum R Value: as indicated on drawings.

E. Sound Attenuation Batt Insulation:

1. Type: Fiberglass insulation equal to Knauf Insulation QuietTherm Sound Attenuation Batts, unfaced fiberglass batt insulation for metal frame construction, complying with ASTM C 665, ASTM E 136, and ASTM E 84 for flame spread.

F. Location: Where indicated on the Drawings. Note: Where batt insulation is indicated on plans, either glass fiber or mineral fiber batt insulation may be used, at general contractor's option.

2.2 BOARD INSULATION

A. Polyisocyanurate:

1. General: ASTM C 1289, Type I, Class 1 fire rated closed cell polyisocyanurate foam core faced with an embossed and scrub resistant, plain white acrylic coated aluminum foil facer on the front and a reflective foil facer on the back and complying with the following properties:

Property	Test Method	Test Method Minimum Requirements
Flame Spread	ASTM E84	<25
Smoke Development	ASTM E84	<450
Moisture Vapor Transmission (ASTM E96 desiccant method)	ASTM E96	<0.1 Perm (5.7ng/(Pa•s•m^2) Class I vapor retarder per ICC
Compressive Strength	ASTM D1621	25 psi
Water Absorption	ASTM C209	<1% by Volume *Typical Results <0.5% by Volume

Dimensional Stability	ASTM D2126	<2% Linear Change *Typical Results <1% Linear Change
Service Temperatures	–	-100°F to +250°F (-73°C
Potential Heat	NFPA 259	12,000 Btu/lb
Auto-ignition Temperature	ASTM D1929	800°F
Recycled Content	–	10.4 - 13.8%

2. Products: Subject to compliance with requirements, products that may be incorporated into the Work include the following:

    a. Atlas EnergyShield Pro
    b. CI Max by Johns Manville
    c. Substitutions: reference section 012500 – Substitution Procedures

3. R-Value: As indicated on drawings or as required by local code.

4. Location: Where indicated on the Drawings.

B. Polyisocyanurate Board Insulation with Facers Both Sides: Rigid cellular foam, complying with ASTM C1289; Type I, aluminum foil both faces; Class 2, glass fiber-reinforced core.

1. Basis of Design:

    a. DuPont de Nemours Inc.; DuPont™ Thermax™ White Finish (WF) Insulation

2. Flame Spread Index (FSI): Class A - 0 to 25 for both core AND finished product, when tested in accordance with ASTM E84.
3. Smoke Developed Index (SDI): 450 or less for both core AND finished product, when tested in accordance with ASTM E84.
4. Thermal Resistance (R-value): Minimum 6 per inch at 75 degrees F (24 degrees C) and minimum 6.6 per inch at 40 degrees F (5 degrees C) in accordance with ASTM C1289
5. Front Facer: 1.25 mil white embossed aluminum.
6. Back Facer: 1.0 mil plain aluminum.
7. Board Thickness: As indicated on the Drawings.
8. Board Edges: Square.
9. Location: Where indicated on the Drawings:

2.3 INSULATION FASTENERS

A. Drilled-in Plastic Anchors: Plastic polypropylene with ribbed shaft and integral washer, capable of holding insulation of specified thickness securely in position.

1. Anchor Length: As recommended by anchor manufacturer for insulation thickness specified.
2. Available Products: Subject to compliance with and meeting manufacturer's requirements.

B. Stick Pin: Hilti IDP Insulation Anchor.

1. Insulation Fasteners: Impaling clip of galvanized steel, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, with washer retainer capable of

securely and rigidly fastening insulation in place. Equal to Midwest Fasteners - Spindle - IHSP.
2. Washer Retainer - Exposed to View: Equal to Midwest Fasteners - Capped Speed Washer - PCW, decorative domed cap, aluminum with white finish.
3. Washer Retainer - Concealed from View: Equal to Midwest Fasteners - Self-Locking Square Washer - WA/WS, aluminum with stainless steel.
4. Adhesive: High strength specifically intended for this purpose and approved by manufacturer.

2.4 FACING COMPOSITION SCRIM / KRAFT VAPOR RETARDERS

A. Basis of Design Manufacturer:

1. Lamtec Corporation 5010 River Road, Mount Bethel, PA 18343 phone: (570) 897-8200 fax: (570) 897-6081, website: www.lamtec.com

a. Meets ASTM C1136, Type II, IV and is paintable
b. Permeance (WVTR) – ASTM E96 (procedure A)
c. Bursting Strength – ASTM D774
d. Puncture Resistance – ASTM C1136
e. Tensile Strength - ASTM C1136
f. Mold Resistance – ASTM C665 /C1338
g. Dimensional Stability – ASTM D1204
h. Light Reflectance – ASTM C523
i. Flame Spread / Smoke Development – ASTM E84 / UL 723

2. Lamtec Corporation or approved equal

B. Product: WMP-10 - White film (Standard Duty)

1. The composite of fiberglass and facing shall have surface burning characteristics not to exceed 25 flame spread and 50 smoke developed when tested in accordance with Underwriters Laboratories 723 test method or ASTM E 84 test method. Facing shall be composed of 0.0015” white metallized polypropylene film, a reinforcing layer, and 14# kraft paper. The product shall be reinforced with a 5x5 tri-directional scrim which has a blend of fiberglass and polyester yarns. The resulting facing shall have a water vapor transmission rate of 0.02 US perm (ASTM E96, Procedure A), and a mullen burst of 65 P.S.I. Tensile strength shall be 40# in the machine direction and 35# in the cross-machine direction. The manufacturer’s name and product identification must be printed on the tab area of the facing.

PART 3 - EXECUTION

3.1 BOARD INSTALLATION

A. General:

1. Verify adjacent materials are dry and ready to receive installation.
2. Verify mechanical and electrical services within the walls have been installed and tested.
3. Apply adhesive to back of boards.
4. Place boards to maximize adhesive contact.
5. Butt edges and ends tightly to adjacent boards and to protrusions.
6. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
7. Tape joints in accordance wit manufacturer’s instructions using compatible products.

B. Interior Walls:

1. Fasten insulation board per ICC ESR code report 1659 (section 4.1.1 application).

a. OPTIONAL and in addition to fastening: Apply adhesive to back of boards using horizontal continuous 3/8” beads placed 2 inches from edges in a zig zag pattern. Press board into adhesive pull back slightly to activate adhesive bond then push back in place.

b. Thermax™ brand insulation boards used in interior applications to be fastened at maximum of 24 inches (610mm) on center along the width of the board and a maximum 48 inches (1219 mm) on center along the length of the board.

2. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
3. Verify that seams are clean, dust free, and dry before applying seam treatment (wipe down with damp cloth and then dry).
4. Install DuPont™ White Foil Tape with squeegee or stiff brush at seams.

3.2 BATT INSTALLATION

A. Install insulation and vapor retarder in accordance with manufacturers' instructions.

B. Verify adjacent materials are dry and ready to receive installation.

C. Verify mechanical and electrical services within walls have been installed and tested.

D. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.

E. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

F. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

G. Walls and Soffits with Metal Stud Framing:

1. Install insulation with vapor barrier towards building interior.
2. Use friction fit between framing members.

H. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.

I. Provide uniform, neat appearing vapor retarder installation upon completion, with clean-cut, square edges.

3.3 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 072100

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SECTION 074100 - ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel faced, polyisocyanurate foamed-in-place insulated roof panels
2. Accessories including fasteners, perimeter trim and penetration treatments

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA)

1. AAMA 501.2: Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

B. American Society of Civil Engineers (ASCE)

1. ASCE 7: Minimum Design Loads for Buildings and Other Structures.

C. ASTM International

1. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
2. ASTM A755: Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Pre-painted by the Coil-Coating Process for Exterior Exposed Building Products
3. ASTM C273: Standard Test Method for Shear Properties of Sandwich Core Materials.
4. ASTM C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
5. ASTM D1621: Standard Test Method for Compressive Properties of Rigid Cellular Plastics
6. ASTM D1622: Standard Test Method for Apparent Density of Rigid Cellular Plastics
7. ASTM D1623: Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
8. ASTM D1929: Standard Test Method for Determining Ignition Temperature of Plastics
9. ASTM D6226: Standard Test Method for Open Cell Content of Rigid Cellular Plastics.
10. ASTM E72; Standard Test Methods of Conducting Strength Tests of Panels for Building Construction
11. ASTM E84; Standard Test Method for Surface Burning Characteristics of Building Materials
12. ASTM E283: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
13. ASTM E1646; Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference
14. ASTM E1680; Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems
15. ASTM G153; Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

16. ASTM G154; Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

D. Underwriters Laboratories

1. UL 580; Tests for Uplift Resistance of Roof Assemblies

E. International Building Code (IBC): current edition

F. Factory Mutual

1. FM 4880Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings, and Exterior Wall Systems
2. FM 4471; Approval Standard for Class 1 Panel Roofs

1.3 RELATED REQUIREMENTS

A. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.4 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation meeting: Conduct a pre-installation meeting at the job site attended by Owner, Architect, Manufacturer's Technical Representative, Panel Installer, and Contractors of related trades. Coordinate structural support requirements in relation to insulated roof and wall panel system, installation of any separate air/water barriers, treatment of fenestration, and other requirements specific to the project.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Manufacturer shall have a minimum of five (5) years experience in the production of insulated metal standing seam roof panels. Manufacturer shall demonstrate past experience with examples of projects of similar type and exposure.

B. Installer Qualifications:

1. Installer shall be authorized by the panel manufacturer and the work shall be supervised by a person having a minimum of five (5) years experience installing insulated metal standing seam roof panels on similar type and size projects.
2. Installation shall be in accordance with manufacturer's installation guidelines and recommendations.

C. Deliver panel materials and components in manufacturer's original, unopened, undamaged packaging with identification labels intact.

D. Store roof and wall panel materials on dry, level, firm, and clean surface. Stack no more than two bundles high. Elevate one end of bundle to allow moisture run-off, cover and ventilate to allow air to circulate and moisture to escape.

1.6 WARRANTY

A. Limited Warranty: Standard form in which manufacturer agrees to repair or replace items that fail in materials or workmanship within specified warranty period. The items covered by the warranty include structural performance and finish performance.

1. Warranty Period: Two (2) years from date of Substantial Completion, or 2 years and 6 months from the date of shipment from manufacturer's plant, whichever occurs first.

B. Finish Warranty: Standard form in which manufacturer agrees to repair or replace metal panels that evidence deterioration of fluoropolymer finish, including flaking or peeling from approved primed metal substrate, chalk in excess, and /or color fading.

1. Warranty Period: Thirty (20) years from date of Substantial Completion, or 20 years and 3 months from the date of shipment from manufacturer's plant, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Kingspan Insulated Panels, Inc., 726 Summerhill Drive, Deland, FL 32724 (888-882-5862); 2000 Morgan Road, Modesto, CA 95358 (800-377-5110) (www.kingspanpanels.us)

B. Kingspan Insulated Panels Ltd. 12557 Coleraine Drive, Caledon, ON L7E 3B5 (866-442-3594); 5202-272nd Street, Langley, B.C. V4W 1S3 (866-442-3594) (www.kingspanpanels.ca).

C. Basis of Design: Kingspan KingSeam roof panels. No substitutions permitted.

2.2 STANDING SEAM ROOF PANELS

A. Design Criteria – Roof Panels:

1. Uplift Rating

a. Design Uplift Load: +55/-66 psf per ASCE 7.

b. Design criteria shall be L/240 for roof.

c. Units shall be rated and carry the following listings:

1) Factory Mutual 1-60 uplift rating for 5 foot spans with minimum 16 gauge purlins
2) Factory Mutual 4471 – Class 1 Approval

2. Fire Classifications

a. Factory Mutual Class 1A Approval when installed at a maximum roof slope of 5:12.

B. Performance Criteria – Wall and Roof Panels:

1. Structural Test: Structural performance shall be verifiable by witnessed structural testing for simulated wind loads in accordance with ASTM E72 and/or ASTM E1592.
2. Water Penetration: There shall be no uncontrolled water penetration through the panel joints at a pressure differential of 20 psf, when tested in accordance with ASTM E1646.
3. Air Infiltration: Air infiltration through the panel shall not exceed 0.036 cfm/sf at 20 psf air pressure differential when tested in accordance with ASTM E1680.
4. Thermal Properties: The panel shall provide a nominal R-value of 7.1 [hr·ft2·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 75°F mean temperature and 7.7 [hr·ft2·°F/Btu] per inch thickness when tested in accordance with ASTM C 518 at 40°F mean temperature

5. Hailstorm Rating for roof panels: Factory Mutual 1 SH hailstorm rating
6. Flame Spread and Smoke Developed Tests on exposed Insulating Core:

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

7. Fire Test Response Characteristics for panels: Steel-faced panels with polyisocyanurate (ISO) core shall fully comply with Chapter 26 of International Building Code regarding the use of Foam Plastic.

    a. FM 4880: Class I rated per FM Global, panels are approved for use without a thermal barrier and do not create a requirement for automatic sprinkler protection.
    b. ASTM D1929 Minimum Flash and Self Ignition; established for foam core.
    c. NFPA 259 Potential Heat Content; established for foam core.
    d. S102, S126 UL Canada fire test standards; successfully passed.

C. Panel Assembly Description:

1. Panel thickness: 3.25 inches thick.
2. Panel width: 40 inches.
3. Panel length: As indicated on drawings
4. The side joint shall consist of a 2 inch vertical sidelap, mechanically seamed, with fasteners and attachment clip completely concealed within the side joint.
5. Exterior Face of Panel:

    a. Material: AZ50/Galvalume/Zincalume per ASTM A 792. Minimum Grade 33
    b. Profile: Shallow “mesa” rib
    c. Texture: Smooth (non-embossed)
    d. Gauge: 26 gauge
    e. Exterior Finish: PVDF finish, dry film thickness of 1.0 mil including primer
    f. Color: Selected from current Kingspan Insulated Panels standard color chart.

        1) SRI: Minimum of 29.

6. Interior Face of Panel:

    a. Material: AZ35/Galvalume/Zincalume per ASTM A792 minimum Grade 33
    b. Profile: Shallow “lightly planked mesa ribs on 2.22” centers
    c. Texture: Smooth (non-embossed]
    d. Gauge: 26 gauge
    e. Interior Finish: modified polyester, dry film thickness of 1.0 mil including primer.

        1) Color: Selected from the current Kingspan Insulated Panels stock color chart

7. Insulating Core: Minimum 95 percent closed cell structure (per ASTM D6226) urethane modified isocyanurate core with the following minimum physical properties:

    a. Density Nominal: 2.1-2.5 pcf per ASTM C1622
    b. Shear Strength: 28-32 psi per ASTM C273
    d. Compressive Strength: 25 psi per ASTM D1621
    e. Dimensional Stability: 28 day aged (ASTM D 2126) -20 degree F < 1% chg, dry heat 200 degree F < 1% chg, Humid Heat 158 degree F
    f. Surface burning characteristics when tested in accordance with ASTM E84:

        1) Flame Spread: less than 25

2) Smoke Developed: less than 450

2.3 ACCESSORIES

A. Fasteners:

1. Self drilling fasteners shall be corrosion resistant plated steel, designed to resist maximum negative pulloff loads and hold the face sheet mechanically to the structural support.
2. Panel attachment clip shall be one piece and fully concealed within the panel sidejoint. Top clip shall be a minimum 20 gauge stainless steel with an integral thermal break.

B. Perimeter Trim and Penetration Treatments: All required trim and metal flashing with same coating, color, and gauge as the exterior face of the insulated metal roof panel.

C. Butyl Tape: Per panel manufacturer's recommendations for panel to panel and panel to trim seal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine alignment of the structure and supports prior to installing the insulated metal roof panels.

1. Structure Tolerance: In the plane of the roof 0 inches inward, plus 3/16 inch outward
2. All deviations from structural tolerances shall be corrected by the responsible party prior to installation of the panels.

B. Examine individual panels upon removing from the bundle; both edges should be visually examined, and any slight overfill of insulation should be carefully removed.

3.2 PANEL INSTALLATION

A. Remove protective film before installation, or immediately thereafter to prevent sunlight damage.

B. Cut panels, where indicated on shop drawings, using a power circular saw with fine tooth carbide tip blades or a band saw prior to installation. Ventilate area where polyurethane dust is generated. Personnel should wear respiratory and eye protection devices.

C. Apply butyl sealant vapor seal around interior perimeter of roof assembly per panel manufacturer's instructions.

D. Apply butyl tape on panel sidelaps and clip assemblies per panel manufacturer's instructions.

E. Secure units to the steel supports with manufacturer's recommended fastener.

F. Place panel fasteners through predrilled top clip and base clip, concealed within the side joint of the panel.

1. Heads of concealed fasteners shall be insulated from the exterior environment to prevent condensation and "ice balling" from occurring on the fastener shaft.

G. Apply endlap sealing tape and butyl to panel surface to be lapped per manufacturer's instructions.

H. Endlap panel stitch fasteners to be vibration resistant type.

I. As each panel is installed, crimp hidden clip assembly prior to placement of next panel.

J. Repair or replace metal panels and trim that have been damaged.

3.3 TRIM INSTALLATION

A. Place trim to determine the location of the closure strips, sealant and ridge closure trims.

B. Apply butyl tape above and below the foam closure strip and seat the closure strip firmly in the tape to ensure a continuous seal. If any voids exist add butyl caulking and reseat the closure.

C. Place a continuous layer of butyl tape on top of the metal ridge closure trims for the length of the building.

D. Fasten the exterior ridge trim to the metal ridge closure trims, per manufacturer's recommendations, on center with 1/4 inch by 7/8 inch low profile vibration resistant stitch fasteners.

3.4 SEALANT INSTALLATION FOR EXPOSED JOINTS AT ROOF PANELS

A. Clean and prime surfaces to receive exterior exposed sealants in accordance with sealant manufacturer's recommendations.

B. Follow sealant manufacturer's recommendations for joint width-to-depth ratio, application temperature range, size and type of backer rod, and compatibility of materials for adhesion.

C. Direct contact between butyl and silicone sealants shall not be permitted.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: General Contractor shall engage an independent testing and inspection agency acceptable to the architect to perform field tests and inspections and to prepare reports of findings.

3.6 CLEANING AND PROTECTION

A. Remove protective film immediately after installation.

B. Touch-up, repair or replace metal panels and trim that have been damaged.

C. After metal roof and wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

D. Clean finished surfaces as recommended by metal panel manufacturer.

E. Repair or replace any damaged or defective panels after determination of responsibility.

END OF SECTION 074100

SECTION 074113 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes standing-seam metal roof panels.

1.2 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in architectural sheet metal products.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer with a minimum of three years experience.

1.4 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A653/A653M Standard Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM A792/A792M Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy Coated by the Hot-Dip Process.
3. ASTM D2247 Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
4. ASTM E1680 Standard Test Method for Determining the Rate of Air Leakage Through Exterior Metal Roof Systems Under Specified Pressure Differences Across the Specimen.
5. ASTM E1646 Standard Test Method for Water Penetration of Metal Roof Systems by Uniform Static Air Pressure Difference.
6. ASTM G90 Standard Practice for Performing Accelerated Outdoor Weathering of Non-Metallic Materials Using Concentrated Natural Sunlight.

1.5 RELATED REQUIREMENTS

A. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels until installation. Remove as panels are being installed. Verify film is not left on installed panels.

1.7 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.8 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show 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 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, chipping, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

B. Special Watertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain watertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.
2. Shop drawings must be provided to, reviewed, and approved by panel manufacturer prior to panel system installation.
3. Inspections by panel system manufacturer technical representative are required. Perform first inspection when underlayment and flashing are in place and second inspection when the roof is complete.

C. Special Installer Warranty: Furnish a written warranty signed by the Panel Applicator guaranteeing materials and workmanship for watertightness of the roofing system, flashings, penetrations, and against all leaks.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to UL 580, Class 90.:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 and ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration of assembly per ASTM E1646 at a minimum differential pressure of 20% of inward acting, wind-load design pressure of not less than 6.24 lb/sq. ft. (300 Pa) and not more than 12.0 lb/sq. ft. (575 Pa

D. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL580, Class 90.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing 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 (Range): 120 deg F, ambient; 180 deg F, material surfaces.

F. Air infiltration in accordance with ASTM E 1680.

G. Fire-Test-Response Characteristics: Where indicated, provide products identical to those tested for fire resistance per ASTM E 119 by a testing agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
2. Identify products with appropriate markings of applicable testing and inspecting agency.

H. Finish Performance Requirements:

1. Color Change and Fade Resistance: No cracking, peeling, blistering or loss of adhesion when tested in accordance with ASTM G23; color change, after removal of surface deposits such as dirt or chalk, maximum 5 Δ Hunter units.
2. Humidity Resistance: No blistering, peeling or loss of adhesion, after 2000 hours testing in accordance with ASTM D2247.

I. Sheet Metal Industry Standard: Comply with Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Architectural Sheet Metal Manual.

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Berridge Manufacturing Company; Cee-lock or comparable product by one of the following: Contact: Mark Eaker at Berridge for pricing. Ph: (702)-241-3943. Email: meaker@berridge.com

    a. Design Span by AEP-Span, Dallas, Texas
    b. UC 14 by Holcim Elevate, Anoka, Minnesota.
    c. Medallion Lok by McElroy Metal. Contact: 1500 Hamilton Rd., Bossier City, LA 71111; Telephone: (800) 562-3576, (318) 747-8097; Fax: (318) 747-8099; E-mail: info@mcelroymetal.com ;

2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

    a. Nominal Thickness: 0.024 inch.
    b. Exterior (Factory) Finish: Organic Coating (Kynar 500 or Hylar 5000): Fluoropolymer, two-coat, thermocured system with fluoropolymer coat.
    c. Painted materials shall have a removable plastic film to protect the paint during roll forming, shipping and handling.
    d. Color: As indicated on the Drawings. Furnish appropriate long-life air-drying system finish in matching color for touchup.

3. Clips: Continuous Cee-Rib with Vinyl Weatherseal Insert to accommodate thermal movement.

    a. Material: 0.024-inch nominal thickness, aluminum-zinc alloy-coated steel sheet.

4. Panel Coverage: 16.5 inches.
5. Panel Height: 1.5 inches.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Grace Ice and Water Shield as manufactured by GCP, Applied Technologies, Cambridge, MA

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.

2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.

E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

F. Panel Fasteners: Zinc-coated steel, corrosion resisting steel, zinc cast head, or nylon capped steel, type and size as approved for the applicable loading requirements.

G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Joint Sealant: Silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.5 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using factory set, non-adjustable, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
3. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. 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 same piece are unacceptable. 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.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75± 0.05 mil (0.0013 mm) over 0.2± 0.05 mil (0.0013 mm) primer coat, to provide a total dry film thickness of 0.95± 0.10 mil (0.024 mm). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

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

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations

indicated below, 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 36 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days or as directed by the underlayment product manufacturer.

1. Apply over the entire roof surface.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.4 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels to be level to 1/4 inch in 20 ft. (6 mm in 6.1 m).
2. Flash and seal metal panels at perimeter of all openings. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Locate and space fastenings in uniform vertical and horizontal alignment.
4. Install flashing and trim as metal panel work proceeds.
5. Panels should be continuous without end laps.
6. Align bottoms of metal panels and fasten.
7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
2. Aluminum Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use stainless-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates, if required, at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied vinyl weatherseal.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, and similar items. Provide types

indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Connect downspouts to underground drainage system where indicated.

J. Roof Curbs: Install flashing around bases where they meet metal roof panels.

K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 FIELD QUALITY CONTROL

A. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

B. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

C. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113

SECTION 075423 - THERMOPLASTIC POLYOLEFIN ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Membrane roofing systems, including insulation, membrane flashing, coverboard, pipe flashing and accessories.

B. Related Requirements:
   1. Section 012500 – Substitution Procedure
   2. Section 013300 – Submittal Procedures
   3. Section 017700 – Closeout Procedure
   4. Section 053100 – Steel Decking
   5. Section 061000 – Rough Carpentry: Wood blocking and nailers.
   6. Section 072100 – Thermal insulation
   7. Section 076200 – Sheet Metal Flashing and Trim: Sheet metal fascia and edge trim, counter flashings, and other sheet metal.
   8. Section 077220 – Roof Accessories: roof hatches.
   9. Section 079200 – Joint Sealants.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. ASTM International:
   1. ASTM C 578 - Rigid, Cellular Polystyrene Thermal Insulation.
   2. ASTM C 1177 - Glass Mat Gypsum Substrate for Use as Sheathing.
   3. ASTM C 1289 - Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   4. ASTM D 6878 - Thermoplastic Polyolefin Based Sheet Roofing.

C. Underwriters Laboratories, Inc. (UL):
   1. UL - Roofing Materials and Systems Directory.
   2. UL 790 - Fire Resistance of Roof Covering Materials.
   3. UL 1256 - Fire Test of Roof Deck Construction.

D. Factory Mutual Research Corporation (FM):
   1. FM Approvals Building Materials Approval Guide, Chapter 3 - Approved Combinations and Assemblies.
   2. FM Global Loss Prevention Data Sheet 1-28 - Design Wind Loads.
   3. FM Global Loss Prevention Data Sheet 1-29 - Roof Deck Securement and Above-Deck Components.
   4. FM Approval Standard 4450 - Class 1 Insulated Steel Deck Roofs.
   5. FM Approval Standard 4470 - Class 1 Roof Covers.

1.3 SYSTEM DESCRIPTION

A. Single Ply Membrane Roofing System: Single ply membrane roofing system consisting of insulation on metal deck with 60 mil reinforced membrane mechanically fastened.

B. Flashing and Waterproofing Membranes: 60 mil reinforced membrane, fully adhered, as defined herein and indicated on the drawings.

1.4 SUBMITTALS

A. See Section 013300 for submittal procedures

B. Submit required submittals within 30 days after contract award.

C. Product Data: Submit Product Data and MSDS sheets for accepted system showing compliance with the specified physical properties.

D. (When required) Testing Reports: Provide Florida Building Code Product Approval Number / Report and Miami-Dade County Product Control Notice of Acceptance.

E. Shop Drawing: Submit Shop Drawings showing:
1. Contractors' approval stamp saying they have reviewed and approved the submittal, and that the submittal meets the requirements of the drawings and specifics.
2. Fastener patterns to meet uplift requirements.
3. Color of products.
4. Layouts for Crickets and saddles.
5. Walk pad layouts.
6. Typical and non-typical Details required for completion but not shown on drawings.
7. Layout of additional fasteners required for wind warranties.
8. Techniques for nighttime or weather tie offs.
9. Sample of manufacturer's warranty.
10. Sample of applicator's warranty.
11. Safety Data Sheets (SDS).

F. Licensed Contractor Letter: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install mechanically fastened roofing system.

G. Closeout Submittals: Comply with the requirements of Section 017000.
1. Letter from manufacturer stating that the roof has been installed in such a manner that the installed system meets the warranty requirements.
2. Roofing Contractor's warranty for work on roofing performed under this contract.

H. Regulatory Requirements Documentation: Submit UL data and assembly drawings showing compliance with Quality Assurance requirements specified below. Submit letter of compliance from the manufacturer certifying compliance with referenced UL roofing system requirements.

1.5 REGULATORY REQUIREMENTS

A. Roof Assembly: Comply with Underwriters Laboratories, Inc. Roofing Materials and Systems Directory and provide roof assembly meeting requirements of UL 1256 for Flame Spread.

B. (When required) Florida Building Code FBC) Requirements:

1. Roof systems shall have Miami-Dade County Product Control Notice of Acceptance (NOA) or Florida Building Code (FBC) Product Approval to meet the requirements of the current Florida Building Code as necessary to obtain permits required for acceptance of work by Jurisdictional Authorities.
2. Provide roof systems approved for design pressures calculated in accordance with the Florida Building Code bearing FBC Product Approval numbers or Miami-Dade County NOA numbers for intended applications and functions of exterior assembly. Provide roof systems tested as an assembly using components stated in product approval documents.
3. Verify acceptance of product approvals by Authorities Having Jurisdiction before fabrication or delivery. The various systems, in their fabrication and installation, shall comply with the approval acceptance criteria and supporting drawings and documentation.
4. Verify products or assemblies have product approval, that product approval numbers are valid and current, and that related construction assemblies and components are used to ensure approval by Authorities Having Jurisdiction. Where approval document numbers specified herein or associated products are not current or not otherwise applicable, notify the Architect by Request for Information (RFI) for clarification.
5. Approval criteria shall take precedence over specific product models and product requirements specified herein. Where components and characteristics associated with the approval documents differ with the requirements stated herein, the approved requirements shall govern and shall be provided.

C. Pre-installation Conference:

1. Contractor shall convene a pre-installation conference at the site, one week prior to commencing work of this Section. Require attendance of parties directly affecting work of this Section, including, but not limited to, the Owner's representative, Contractor, Roofing Applicator, and job foreman, Mechanical and Plumbing sub-contractors, Owner’s Independent Roofing Inspector, and Roofing Manufacturer's Representative.
2. Contractor shall notify all attendees at least two weeks prior to the conference.
3. Contractor shall review preparation and installation procedures as well as coordinating and scheduling required with related work.
4. Contractor shall record discussions of conference and decisions and agreements (or disagreements) reached and furnish copy of record to each party attending. Review foreseeable methods and procedures related to roofing work, including the following:
    a. Tour, inspect and discuss condition of substrate, roof drains, roof drain final locations, curbs, penetrations, roof hatch installation as it relates to the roof ladder location, and other preparatory work performed by other trades.
    b. Review structural loading limitations of deck as defined below and inspect deck for loss of flatness and for required mechanical fastening.
    c. Review roofing system requirements (drawings, specifications and other contract documents including submittals).
    d. Review required submittals.
    e. Review and finalize construction schedule related to roofing work and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
    f. Review required inspections, testing, certifying, and material usage accounting procedures.
    g. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions, including possibility of temporary roofing (if not a mandatory requirement).

1.6 QUALITY ASSURANCE

A. The Owner shall engage an independent roofing consultant to monitor the installation of the roofing assemblies, review all submittals and shop drawings and attend the pre-installation meeting.

B. Manufacturer: Obtain primary flexible sheet roofing from a single manufacturer. Provide secondary materials as recommended by manufacturer of primary materials.

C. Performance Standards
1. UL listing: Provide labeled materials tested and listed by UL in “Building Materials Directory” or by other nationally recognized testing laboratory for application indicated, with “Class A” rated materials/system for roof slopes shown.
2. Warranty must provide for wind speed coverage for a maximum 3 second gust of **90 mph** measured at 33 feet above the ground.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall make arrangements for delivery of materials in manufacturer's original unopened containers, dry, undamaged, seals and labels intact.

B. Contractor shall store materials in weather-protected environment, clear of ground and moisture. Storage requirements for insulation are as follows:
1. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and any other source.
2. Cut or remove plastic shipping wrap from insulation.
3. Cover with tarpaulin, shield from moistures and ultraviolet rays.
4. Elevate minimum of 4 inches above substrate.
5. Secure to resist high winds.
6. Distribute insulation stored on roof deck to prevent concentrated loads.
7. Do not install wet or damaged insulation.

C. Store liquid and semi-liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

D. Protect adjacent materials and surfaces against damage from roofing work. Do not store materials on completed roofing.

E. Handle and store roofing materials and placer equipment in a manner to avoid permanent deflection of the roof deck.

F. Handle all materials to prevent damage. Place all materials on pallets and fully protect from moisture.

G. Membrane rolls shall be stored lying down on pallets and fully protected from the weather with clean tarpaulins. Unvented tarpaulins are not accepted due to the potential accumulation of moisture beneath the tarpaulin which may affect the membrane weldability.

H. As a general rule, all adhesives shall be stored at temperatures between 40° F (4°C) and 80°F (27°C. Read product data sheets and instructions contained on adhesive canisters for specific storage instructions.

I. All flammable materials shall be stored in a cool, dry area away from sparks and open flames. Follow precautions outlined on containers and read product Safety Data Sheets (SDS).

J. Any materials which the Owner's or manufacturer's representative determine to be damaged are to be removed from the job site and replaced at no cost to the Owner.

K. Safety Data Sheets (SDS) shall be available at the job site at all times.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Only as much of the new roofing as can be made weathertight each day, including all flashing and detail work, shall be installed. All seams shall be heat welded before leaving the job site that day.

B. Temporary overnight tie-ins shall be installed at the end of each day's work and shall be completely removed (including any contaminated materials) before proceeding with the next day's work.

C. The Applicator is cautioned that certain membranes are incompatible with asphalt, coal tar, heavy oils, roofing cements, creosote and some preservative materials. Such materials shall not remain in contact with these membranes.

D. The Applicator shall follow all safety regulations as required by OSHA and any other applicable authority having jurisdiction. Roof and walkways may be slippery when icy, snow covered, or wet. Working on surfaces under these conditions is hazardous. Appropriate safety measures must be implemented prior to working on such surfaces. Always follow OSHA and other relevant fall protection standards when working on roofs.

E. Substrate Conditions: Do not begin roofing installation until substrates have been inspected and are determined to be in satisfactory condition.

F. Where applicable, the Applicator shall arrange for pullout tests in accordance with the latest versions of the SPRI/ANSI Standard Field Test Procedures FX-1 and IA-1 for fasteners and adhesives, respectively, to verify condition of the deck/substrate and to confirm expected pullout values

G. Weather: Proceed with roofing work when existing and forecasted weather conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements.

H. If this roofing system is installed during windy conditions or on projects that are not encapsulated precautionary measures must be taken to utilize temporary ballast during installation.

I. The membrane shall not be installed under the following conditions without consulting manufacturer's Technical Dept. for precautionary steps:
   1. The roof assembly permits interior air to pressurize the membrane underside.
   2. Any exterior wall has 10% or more of the surface area comprised of opening doors or windows.
   3. The wall/deck intersection permits air entry into the wall flashing area.

J. Follow industry standards for environment requirements including, but not limited to, the following:
   1. Do not apply roofing membrane during inclement weather. When air temperature is expected to fall below 40 degrees F, follow specified Cold Weather Application Procedures as specified herein.

2. Do not apply finished roofing system to wet, damp or frozen deck surface or when precipitation is occurring.
3. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.

1.9 SEQUENCING AND SCHEDULING

A. Contractor shall coordinate the Work with installation of associated metal counter flashings specified under other sections as the Work of this Section proceeds.

B. Contractor shall complete installation of base flashing at roof curbs prior to setting roof top equipment.

1.10 WARRANTY

A. See Section 017700 – CLOSEOUT PROCEDURES.

B. System Warranty: Provide manufacturer's total system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
1. Warranty Term: 20 years.
2. For repair and replacement include cost of both material and labor in the warranty.
3. The maximum wind speed coverage shall be peak gusts of **90 mph** measured at 33 feet above ground level.
4. Warranty is to be a non-prorated warranty with a no dollar liability limit. System warranty to include membrane, insulation, adhesives, fasteners metal edging and trim and any other primary roofing products.
5. Warranty shall be transferable.
6. The roofing system manufacturer's warranty shall include roof edge metal and the installation of that edge metal in the warranty. See Section 076200 – Sheet Metal Flashing and Trim.
7. Insulation to be provided and approved in writing by roofing membrane manufacturer.
8. The contractor shall provide a 2-year warranty covering all other roof-related items.

C. Provide a warranty commencing at the date of Substantial Completion, that includes cost of labor and materials for loss of weather tightness without financial limit for a period of 20 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer Contact Information:
1. Carlisle SynTec, (413) 262-8928
2. Holcim Elevate, (800) 428-4442.
3. Johns Manville Roofing Systems, (303) 978-2176
4. GAF, (678) 920-9237

2.2 SYSTEM DESCRIPTION

A. TPO: Thermoplastic single ply membrane composed of thermoplastic polyolefin (TPO) sheet as specified for the specific product hereinbefore and reinforced with polyester scrim conforming to ASTM D 6878.

B. Membrane Type: Reinforced, 60 mil thickness, white (match existing membrane color), 10 ft. maximum sheet width. Roofing assembly Requirements:

1. Solar Reflectance Index (SRI): 78, minimum, calculated in accordance with ASTM E 1980.MEMBRANE PHYSICAL PROPERTIES
   a. Field applied coating may not be used to achieve specified SRI
2. Roof Covering External Fire-Resistance Classification: UL Class A.
3. Factory Mutual Classification: Class I and windstorm resistance of **IA-60**, in accordance with FM DS 1-28.
   a. Design Wind Speed: **90 Vasd, 115 Vult**
   b. Exposure: C.
   c. Surface Roughness C
   d. Risk Category II
4. Insulation Thermal Value (R), LTTR-30; provide insulation of thickness required in two (2) layers.
5. Seaming Materials: As recommended by membrane manufacturer.
6. Membrane Fasteners: As recommended and approved by membrane manufacturer.

2.3 FLASHING MEMBRANE

A. Flashing Membrane: Reinforced and non-reinforced membrane and pressure-sensitive flashing by Roofing System manufacturer, minimum 60 mils, specifically designed for use in flashing at perimeters and wall, and around projections through roofing system.

2.4 Vapor Retarder when required:

A. Over Roof Deck: Non-reinforced Polyethylene film (6 mil) clear sheeting with vapor transmission of 0.20 perms or less.

2.5 ROOF INSULATION

A. Isocyanurate Foam Insulation: Polyisocyanurate board insulation, ASTM C 1289, Type II, Class 1, glass-fiber mat facer on both major surfaces, with an **LTTR (Long Term Thermal Resistance) value of 30** (or meet Energy Code requirements if higher) based on ASTM C1303 and CAN/ULC S770.
   1. Manufacturers:
      a. HPH, by Carlisle.
      b. ISO 95+ GL, by Holcim Elevate.
      c. ENRGY3 or ISO3 by Johns Manville.

   2. Substitutions:
      a. Products meeting the specified requirements by other manufacturers as recommended by the roofing membrane manufacturer.
      b. Reference section 012500 – Substitution Procedure

B. Insulation Assembly:
   1. Insulation: Isocyanate Foam, laid in two (2) equal layers meeting a minimum **LTTR value of 30**.
   2. Expanding spray foam insulation/sealant is to be applied at the perimeter edge and all gaps in the insulation that exceeds ¼". The spray foam insulation/sealant is to be compatible with all elements of the roof system.
   3. Cover board: As specified in this specification section.
   4. Fasteners: Provide 20-gauge factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to the selected roofing system manufacturer.
   5. TPO roofing membrane as specified in this specification section.

C. Roof Curb Insulation: Polyisocyanurate Foam; both faces covered with glass fiber felt; thickness to match wood nailer.

D. Tapered Insulation: Provide crickets, saddles, and tapered insulation of same material as roof insulation; taper to the following slopes:

1. Crickets and Saddles: 1/2 inch per foot (1/4 inch per foot positive slope).
2. Insulation Installed to Counter slope the Roof Structure: 1/2 inch per foot.
3. Edge Taper Insulation: Adjacent to gutter assembly, slope at minimum rate of 1/2 inch per foot. Provide insulation having a starting thickness of 1 inch, tapering insulation up to match nominal roof insulation thickness.

2.6 INDUCTION FASTENING SYSTEM

A. Basis of Design: Holcim Elevate. (Equals will be considered).

B. Induction Fastening System:
1. Non-membrane penetrating fastening system for installing roof insulation and thermoplastic membrane roofing.
2. Fastening system uses same plates and fasteners to secure roof insulation and membrane roofing to roof deck or purlins without penetrating roof materials.
3. Electromagnetic induction welding process bonds the underside of membrane roofing to top of coated plates.
4. FM Rating for Wind Uplift as specified in this section.
5. Approval: FM.

C. Induction Welding Tools: OMG Roofing Products “RhinoBond” induction welding tool.

D. Magnetic cooling clamps.

E. Materials:
1. Plates: Elevate Building Products "Invisiweld" plates. (Substitutions to Invisiweld will be considered).
    a. Secures roof insulation and TPO membrane roofing.
    b. Type:
        1) TPO-Type Plates:
            a) Coated, compatible with TPO membrane roofing.
            b) Color: yellow
    c. Diameter: 3 inches
    d. Thickness: 22 gauge
    e. Material: Coated Galvalume
    f. Coating Corrosion Resistance: Meets FM Approval Standard 4470 criteria.
    g. Profile: Recessed center and raised flat bonding surface.
    h. FM approved.
2. Fasteners:
    a. Elevate “HD Fasteners”:
        1) Secures roofing materials to 22-gauge steel deck.
        2) Head:
            a) #3 Phillips truss head
            b) Diameter: 0.435 inches
        3) Thread Diameter: 0.275 inches
        4) Thread per inch: 12
        5) Shan Diameter: 0.202 inches
        6) Length: sufficient length to penetrate steel deck to top of flute a minimum of 1 inch.
        7) Drill point.
        8) Heat Treated.
        9) Coating: corrosion-resistance: Meets FM approval Standard 4470 criteria.

3. Roof Insulation:
   a. Specified above.
   b. Do not use induction fastening system with the following roof insulation types:
      1) Extruded polystyrene (XPS)
      2) Expanded polystyrene (EPS)
      3) Foil-faced insulation boards, unless covered with a minimum of 1-inch cover board.
      4) Insulation that will melt by use of induction welding process.

2.7 COVER BOARD

A. ASTM C 1177, glass-mat, water resistant gypsum substrate, refer drawings for thickness.
   1. Manufactures: Ensure compatibility with insulation and membrane manufacturer requirements.
   2. Substitution:
      a. Products meeting the specified requirements.

2.8 ROOF PENETRATION FLASHING AND SEALS

A. Molded Pipe Flashing: Pre-molded flexible pipe flashing as recommended and supplied by the roofing manufacturer.

2.9 ACCESSORIES

A. Provide accessories as shown on the drawings and manufacturer's system accessories for a complete and warranted Roofing System, including, but not limited to, the following:

1. Weathered Membrane Cleaner as recommended by the roofing manufacturer.
2. Lap Sealant as recommended by the roofing manufacturer.
3. Bonding Adhesive as recommended by the roofing manufacturer.
4. Membrane Fasteners as specified in this section.
5. Termination Bar as recommended by the roofing manufacturer.
6. Insulation Fasteners: appropriate for purposes intended and approved by roofing manufacturer. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.
7. Walkway / Isolation Pads: factory-formed, nonporous, heavy duty slip resisting, surface-textured walkway approximately 3/16 inch (5 mm) thick provided by selected roofing manufacturer.
8. Preformed Accessories including Pipe Flashings" Prefabricated flexible boot and collar for pipe stacks through membrane: same manufacture as the membrane.
9. Preformed Corner Patching: as recommended by the roofing manufacturer.
10. Draw Bands: stainless steel as required.
11. Foam Filler Insulation: Polyurethane Expanding Foam as recommended by the roofing manufacturer.
12. 3-inch & 6-inch in-seam tape as recommended by the roofing manufacturer.
13. Pressure-sensitive flashing: as recommended by the roofing manufacturer.
14. Primer: as recommended by the roofing manufacturer.
15. In-seam plates: as recommended by the roofing manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The verify deck is clean and smooth, free of depressions, waves, or projections, properly sloped to drains, valleys, and eaves. Verify flutes of steel deck are evenly spaced at intersections. Defects in the substrate surface shall be reported and documented.

B. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips, nailing strips, and reglets are in place. Verify deck is supported and tightly secured.

C. Verify surfaces are dry and free of water, snow, and ice.

D. Verify that positive roof slope exists in all areas.

E. Verify location dimensions and elevations of primary and secondar roof drainage components including roof drains and overflow scuppers.

F. Beginning installation means acceptance of substrate and pre-installation conference has been held with agreements reached.

3.2 PREPARATION

A. Provide covers and other means of protection as necessary to protect building surfaces against damage during roofing work.

B. Where Work will continue over finished roof membrane, protect surfaces from damage.

C. Comply with membrane roofing system manufacturer's written instructions for installing the selected roofing system.

3.3 Vapor Retarder (where required)

A. Install vapor retarder over the metal deck prior to installation of the rigid roof insulation.
   1. Overlap all seams by a minimum of six inches.
   2. Tape all seams and openings.

B. Do not install vapor retarder over breathable metal deck.

3.4 ROOF INSULATION INSTALLATION

A. Place long edge of boards parallel to deck flutes, forming joint over solid bearing. Lay insulation units with long edge joints continuous and end joints staggered. Mechanically fasten insulation, through fire resistive layer if specified, to deck with UL approved fasteners and plates in accordance with requirements of UL.

   1. Install fasteners using drill with torque clutch; other types of drills will not be permitted.
   2. In no case shall the number of fasteners be less than indicated in approved submittals.

B. Lay insulation boards to moderate contact without forcing joints. Cut insulation to fit neatly around protrusions through roof. At parapet walls, cope insulation around protrusions and embed plates; butt tight to wall, sealing conditioned building. Membrane should not be placed over any joint over ¼”.

1. Fill gaps over 1/4 inch wide with Foam Filler Insulation as recommended by the roofing manufacturer. After foam sets and before installation of membrane, trim foam flush with insulation surface.

C. Place roof crickets and tapered insulation to ½" per foot slope pattern in accordance with Contract Documents and manufacturer's instructions.

D. Apply no more insulation than can be sealed with membrane in same day.

E. Adhere a single layer of insulation to manufactured metal curbs with bonding cement.

3.5 ROOFING MEMBRANE APPLICATION

A. Mechanically Fastened Membrane:

1. Starting at low point of roof surface, run membrane perpendicular to roof slope. Unroll membrane over prepared substrate, lapping adjoining sheets as recommended by manufacturer.
2. Mechanically fasten membrane using manufacturer's fastening system. Install fasteners in accordance with the submitted engineered layout pattern to resist specified wind uplift.
3. Install fasteners using drill depth sensing or torque limiting screw guns to limit under / over drive of fasteners.

    a. Drill motors and other non-limiting drivers shall not be used.

4. Seam Sealing

    a. TPO Heat-weld seams according to the system manufacturer's recommendations, and with a minimum weld width of 1-1/2 inches.

B. Cold Weather Application Procedures: When air temperature is expected to fall below 40 degrees F, follow Cold Weather Application Procedures as follows:

1. Store materials in heated storage units prior to installation. Rotate adhesive, cement, and sealant containers to maintain their temperature above 40 degrees F.
2. Allow membrane to relax until no wrinkles are visible.
3. Allow adequate time for solvents in cement to flash off. Check dryness of applied cement before sealing joints.
4. Verify that frost, dew, and other forms of moisture have evaporated prior to covering insulation with membrane to prevent entrapment of moisture within finished roof system.

3.6 WATER CUTOFFS AND WEATHER PROTECTION

A. Install water cut-offs at end of day's operation to seal insulation and edge of roof membrane from moisture entry. If inclement weather appears imminent during roofing application, cease operations and protect deck, insulation, flashings, penetrations and membrane from moisture infiltration with water cutoffs. Insulation and roofing materials not so protected prior to inclement weather will be considered damaged and will be cause for rejection.

B. Remove water cut-offs and other temporary weather protections prior to continuing roofing work. Remove materials that have been subject to moisture damage and return the deck to a clean, dry condition before proceeding with roofing operations. Remove damaged materials from job site.

C. The water cut-offs and weather protection shall not be considered a part of the final roof system specified.

3.7 INDUCTION FASTENEND ROOF MEMBRANE INSTALLATION OPTION

A. Induction fastening membrane roofing over area to receive roofing and install according to roofing system manufacturer's written instructions.
   1. For in-splice attachment, install membranes roofing with long dimension perpendicular to steel roof deck flutes.

B. Start installation of membrane roofing in presence of roofing system manufacturer's technical personnel.

C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Mechanically fasten or adhere membrane roofing securely at terminations, penetrations, and perimeter of roofing.

E. Apply membrane roofing with side laps shingled with slope of roof deck where possible.

F. Induction Attachment: Secure TPO sheet using Invisiweld fastening plates and Induction welding tool to confirm attachment in accordance with manufacturer's Requirements for warranty.

G. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
   2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
   3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

H. At intersections with vertical surfaces:
   1. Extend membrane up a minimum of 8 inches onto vertical surfaces.
   2. Fully adhere flexible flashing over membrane and up to nailing strips.
   3. On all curbs, the flashing shall be bonded to the roofing membrane and turned up the curb and terminate beneath the curbs or mechanical equipment curb cap flashing.

I. Around roof penetrations, seal flanges and flashings with flexible flashing.

J. Roof Drains: Install in accordance with membrane manufacturer's details.
   1. Properly secure all bolts to provide 100-percent continuous compression of the clamping ring.
   2. Do not run field seams through drains.
   3. Insulation shall be tapered around the drain to provide positive drainage, prevent the membrane from bridging, and provide a smooth transition from the roof surface to the drain clamping ring.
   4. The seal between the membrane and the drain base shall be provided by polysulfide or polyurethane sealant under constant, even compression from the drain clamping ring.
   5. When detailing drains, install a new target patch of PVC membrane, within the entire sumped profile. Cut a circular sheet opening of a diameter slightly greater than drainpipe diameter. Bolt holes within the new membrane shall be cut round only, no straight or crosscuts allowed.
   6. Cut membrane neatly to provide full access to drain outlet pipe.

K. Metal Work:
1. Install and anchor in a manner that prevents damage from buckling or wind, in accordance with SMACNA guidelines or in manner approved by membrane manufacturer.
2. Seal and waterproof in an acceptable manner to prevent leakage.
3. Make and install edge metal assemblies at perimeter in accordance with membrane manufacturer's details.

L. Install membrane roofing and auxiliary materials to tie into existing roofing to maintain weather tightness of transition and to not void warranty for existing membrane roofing system.

3.8 MEMBRANE FLASHING AND ACCESSORIES

A. Apply flexible flashings to seal membrane to vertical elements using manufacturer's standard peel and stick flashing.

1. Reinforced Flashing Membrane: Where conditions permit, flash penetrations and walls with reinforced flashing membrane.
2. Uncured Flashing: Limit use of uncured flashing to overlay vertical seams as required at angle changes, to flash inside and outside corners, scuppers, and other penetrations or unusually shaped walls as approved by the manufacturer.

B. Roof Penetrations:

1. Molded Pipe Flashing: Install where configuration of penetration will permit.

2. Install flashings per manufacturer’s instructions.

3. Comply with manufacturer’s recommendations for penetrations larger than 6 inches.

C. Seal flashings and flanges of items penetrating membrane.

D. Fasten termination bars at 12 inches on center or less to maintain constant compression.

E. Isolation Pads: Install isolation pads at pipe supports.

F. Walkway Pads: Install walkway pads as shown in the drawings. Maximum pad section length shall be 10 ft. with three inch spacing between pad sections, unless otherwise indicated on Drawings. Adhere pads to roofing system to prevent displacement in maximum anticipated design wind velocity and to allow drainage of moisture from beneath pads. Install pads to allow roof surface drainage without ponding water. Install pads after adjacent equipment installation.

3.9 WATERPROOFING MEMBRANE

A. Waterproofing Membrane: Install waterproofing membrane to be fully adhered to parapet using bonding adhesive as recommended by membrane manufacturer. Run membrane waterproofing over top of parapet and turn down front side of parapet 3 inches.

1. Provide continuous weather tight seal from 3" below parapet cap, over parapet, down interior face, and onto roof surface.
2. Conceal adhesive on exterior face of parapet with waterproofing.

B. Waterproofing Flashing: Apply waterproofing membrane flashings to seal membrane to vertical elements using manufacturer's peel and stick flashing.

1. Reinforced Waterproofing Flashing: Where conditions permit, flash walls with reinforced waterproofing flashing or as required by the manufacturer.
2. Uncured Flashing: Limit use of uncured flashing to overlay vertical seams as required at angle changes, to flash inside and outside corners, scuppers, and other penetrations or unusually shaped walls where use of reinforced waterproofing flashing is not practical or as required by the manufacturer.

3.10 FIELD QUALITY CONTROL

A. Field quality control shall be the responsibility of the Contractor in accordance with Section 014000. Except as specified as mandatory, field quality control testing and inspection shall be at the discretion of the Contractor as necessary to assure compliance with Contract requirements.

B. Manufacturer’s Site Inspections:

1. Provide site inspection and reports by the manufacturer's representative as required by the manufacturer to maintain the existing warranty.
2. Provide site inspection and reports by the manufacturer's representative for new roofing at the following periods:

    a. At pre-installation conference to inspect:
        1) The surfaces to which the membrane roofing is to be applied are in a condition suitable for this application.
        2) The materials to be installed comply in all respects with the requirements of this specification.
        3) The materials can be installed in complete accordance with the manufacturer's recommended methods of installation.

    b. At 100% completion of roof installation.

3. Inspection shall conform to the inspection requirements specified herein.
4. Identify defects to Owner.
5. Perform a final audit 10 months after acceptance with Owner representative as scheduled by Owner.

C. Take core samples and report information when determined to be necessary to verify the insulation thickness by the IRI.

D. Correct identified defects or irregularities.

3.11 CLEANING

A. Replace defaced or disfigured finishes caused by Work of this Section.

3.12 PROTECTION

A. Where construction traffic must continue over finished roof installation, protect roof surfaces as recommended by roofing system manufacturer to protect manufacturer's warranty.

3.13 MAINTENANCE AND REPAIR DURING CONSTRUCTION

A. The Contractor shall maintain the entire roofing system and related work until issuance of Certificate of Occupancy. Maintenance shall consist of repair of material or installation defects or damage resulting from any subsequent work on the roof or from any weather related damage. Maintenance shall be to maintain the roof system in a watertight condition including repair of conditions that show signs of inferior workmanship that may result in potential leaks. Leaks occurring during the maintenance shall be repaired in accordance with good roofing practice and the requirements specified herein. The Contractor shall remove and replace all wet insulation caused by water leaks and repair the Roofing System.

END OF SECTION 075423

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fabricated sheet metal items, including flashings and counter flashings.
2. Sealants for joints within sheet metal fabrications.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 061000 – Rough Carpentry: Wood nailers for sheet metalwork.
3. Section 075423 - Thermoplastic Membrane Roofing: Roofing system.
4. Section 079200 - Joint Sealers.

1.2 REFERENCE STANDARDS

A. ANSI/SPRI ES-1 - Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

1.3 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

B. Roof edge metal assemblies including copings, fascias and gravel stops shall be designed in accordance with ANSI/SPRIES-1.

1.4 DELIVERY, STORAGE, ANDHANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials that could cause discoloration or staining.

1.5 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Warrant flashing and sheet metal work to be free of defects in materials and workmanship fora period of two years from Date of Substantial Completion.

C. Roof edge metal assemblies shall be included in the roof system warranty.

D. Prefinished Metal: Warrant against fading and peeling for a period of 10 years.

PART 2 PRODUCTS

2.2 SHEET MATERIALS

A. Pre-Finished Galvanized Steel: ASTM A 653/A 653M, with G90/Z275 zinc coating; minimum.0239 inch (24 gage) thick base metal, shop pre-coated with PVDF coating.

1. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as selected from manufacturer's standard colors.
2. Underside shall be coated with manufacturer's standard wash coat.

2.3 FASTENERS:

A. Generally composed of same materials as flashings being fastened. Exposed fasteners shall have 5/8 inch steel/neoprene washers under the head. Fasteners shall be treated for resistance to rust and corrosion.

1. Sheet Metal to Wood:

a. Concealed Application: Annular threaded nail with minimum 3/16 inch diameter head, not less than 12 gauge and of sufficient length to penetrate substrate 1-1/4 inch minimum.
b. Exposed Application: No. 10 screws minimum. Penetrate wood blocking minimum 1-1/2 inches. Installed withdrawal resistance shall be a minimum of 150 pounds per screw.

2. Sheet Metal to Sheet Metal: Self-tapping sheet metal screws of 1/2 inch length and a minimum No. 8 diameter.
3. Concrete and Masonry Anchors: Specially threaded anchors, 3/16 inch minimum diameter, length to penetrate minimum 1-1/2 inches into concrete or masonry. Installed withdrawal resistance shall be a minimum of 150 pounds per anchor.

2.4 FABRICATION

A. Shop fabricate work to greatest extent possible. Comply with details shown and with applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry practices. Fabricate for waterproof and weather resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, damage or deterioration of the work. Form work to fit substrates.

B. Provide gage suitable for purpose as recommended by SMACNA Manual.

C. Form sections true to shape, accurate in size, square, and free from distortion or defects.

D. Form pieces in longest possible lengths.

E. Hem exposed edges on underside 1/2 inch; miter and seam corners.

F. Fabricate corners from one piece with minimum 4 inch nor more than 12 inch long legs; seam for rigidity, seal with sealant.

G. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

H. Blind clips and cleats shall be at least the same gauge as sheet metal flashing.

2.5 SCHEDULE

A. Gutters:

1. Material: Galvanized steel, minimum 24 gage.
2. Design: SMACNA Figure 1-2, style A.
3. Expansion Joint: SMACNA Figure 1-6, lap type expansion joint at 50 feet on center maximum.
4. Supports: Support gutter on 1/4 inch x 1-1/2 inch galvanized steel brackets at 30 inches o.c. and outer edge of gutter with metal straps staggered at 30 inches o.c. with brackets in accordance with SMACNA Figure 1-13A.

B. Downspouts:

1. Material: Galvanized steel, minimum 24 gage.
2. Design: SMACNA Figure 1-32B.

C. Downspout Hangers:

1. Material: Galvanized steel, 20 gage.
2. Design: SMACNA Figure 1-35A.

D. Gravel-Stop Fascia:

1. Material: Galvanized steel, minimum 24 gage.
2. Design: SMACNA Figure 2-1B.

E. Coping:

1. Material: Galvanized steel, minimum 24 gage.
2. Design: SMACNA Figure 3-4A; slope top 1/2 inch.
3. Joint Design: SMACNA Figure 3-3, style 19; butt seam with 12 inch wide backup plate. Fabricate in 10 foot lengths with 1/2 inch minimum joint for expansion and contraction.

F. Overflow Scupper:

1. Material: Galvanized steel, 24 gage, soldered construction.
2. Design: SMACNA Figure 1-30, modified in accordance with details indicated on drawings (if provided).
3. Fabricate scuppers with minimum 4" wide roof side flange. Cross section of scupper shall be ½" less in width and height than the parapet opening.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.2 INSTALLATION

A. Except as otherwise indicated, comply with the installation recommendations of SMACNA and Factory Mutual Data Sheet 1-49 Perimeter Flashing.

B. Coordinate flashing at roof surfaces with roofing work to provide weather-tight condition at roof terminations.

C. Sheet metal items shall be installed true to line, without buckling, creasing, or warp.

D. Anchor units of work securely in place, providing for thermal expansion of metal units. Conceal fasteners where possible. Exposed fasteners shall be covered with sealant.

E. Fastening:

1. Nails: Confine to one edge only of flashing 12" or less in width. Space nails at 4" o.c. max
2. Cleats: Continuous, formed to profile of item being secured.
3. Clips: Minimum 2" wide by 3" long formed to profile of item being secured. Space at 24" o.c. maximum except as otherwise indicated.

F. Downspouts:

1. Secure downspouts to exterior walls at 10 feet on center maximum. Lap downspout joints 1-1/2 inch and rivet.
2. Provide downspout terminations at grade. Provide connection to underground storm drain system where indicated on Drawings. Extend 2 inches into PVC cap, and apply sealant all around.

G. Roof Penetration Flashing: Flash and install penetrations in accordance with sheet roofing manufacturer's product data.

END OF SECTION 076200

SECTION 077220 - ROOF ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof hatches, LadderUP safety post, prefabricated hatch rail system, and fall arrest systems.

B. Related Requirements:

1. Section 076200 - Sheet Metal Flashing and Trim: Roof accessory items fabricated from sheet metal.

1.2 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used.

1.3 DELIVERY, STORAGE, ANDHANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.1 GENERAL

A. Reference individual products for approved manufacturers

2.2 MANUFACTURERS

A. Acudor Products Inc: www.acudor.com

B. Babcock-Davis: www.babcockdavis.com

C. Bilco Co.: www.bilco.com

D. Diversified Fall Protection, LTD: 24400 Sperry Drive, Cleveland, OH 44145

E. Dur-Red Products: www.dur-red.com

F. Flexible Lifeline Solutions: 2437 Peyton Rd, Houston, TX 77032
   1. Josh Vogel: (832) 808-9384; josh.vogel@flexiblelifeline.com
   2. Emily Aulds: (832) 448-2900; Emily.aulds@flexiblelifeline.com

G. Honeywell Industrial Safety

H. OZ Lifting Products, 5455 W. 6th Street, Winona, MN 55987 (507) 474-6250

I. Safety Rail Company, LLC: 4244 Shoreline Drive, Spring Park, MN 55384
   1. Patrick Deering: (303) 803-2361; Patrick.deering@safetyrailcompany.com

2. Andrew Bruner; Andrew.Bruner@safetyrailcompany.com
3. Adam Mochinski: (952) 594-3512; adam.mochinski@safetyrailcompany.com
4. Tom Kelly: tom.kelly@safetyrailcompany.com

J. Tritech Fall Protection
1. Meridith Conser: (407) 835-777; Meridith.C@tritechfallprotection.com
2. Ryan Powell: (407) 835-9777; Ryan.P@tritechfallprotection.com

K. Substitutions by other vendors not allowed.

2.3 ROOF HATCHES

A. Manufacturers:

1. Acudor Products Inc.
2. Babcock-Davis
3. Bilco Co.
4. Dur-Red Products.
5. Substitutions by other vendors not allowed.

B. Roof Hatches:

1. Factory-assembled aluminum frame and cover, complete with operating and release hardware.
2. Style: Provide flat metal covers unless otherwise indicated.
3. For Ladder Access: Provide Type S roof hatch, 30 inches x 36 inches.
4. For Stair Access: Single leaf; 37 by 96 inches.
5. Design Wind Speed: See Structural Drawings. Loading shown on Structural Drawings

C. Frames/Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.

1. Material: Mill finished aluminum, 11-gauge, 0.0907 inch thick.
2. Insulation: 1 inch rigid glass fiber, located on outside face of curb.
3. Curb Height: 12 inches from surface of roof deck, minimum.

D. Metal Covers: Flush, insulated, hollow metal construction.

1. Material: Mill finished aluminum; outer cover 11 gage, 0.0907 inch thick, liner 0.04 inch thick.
2. Insulation: 1 inch rigid glass fiber.
3. Gasket: Neoprene, continuous around cover perimeter.

E. Safety Railing System: Manufacturer's standard accessory safety rail system mounted directly to curb.

1. Comply with OSHA 29 CFR 1910.23, with a safety factor of two.
2. Posts and Rails: Fiberglass reinforced polymer.
3. Gate: Same material as railing; automatic closing with latch.
4. Finish: Manufacturer's standard; molded in integral safety yellow.
5. Gate Hinges and Post Guides: ASTM B221 (ASTM B221M), 6063 alloy, T5 temper aluminum.
6. Mounting Brackets: Hot dipped galvanized steel, 1/4 inch thick, minimum.
7. Fasteners: Type 316 stainless steel.

F. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.

1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.
2. Hinges: Heavy duty pintle type.
3. Hold open arm with vinyl-coated handle for manual release.
4. Latch: Upon closing, engage latch automatically and reset manual release.
5. Locking: Padlock hasp on interior.

2.4 LADDER UP SAFETYPOST

A. Manufacturer: The Bilco Company
1. Model: LU-1 LadderUp safety post (Basis of Design)

B. Product:
1. Telescoping tubular steel section that locks automatically when fully extended.
2. Upward and downward movement shall be controlled by a stainless steel spring balancing mechanism.
3. Finish: black enamel finish.
4. Install on fixed ladder below hatch cover. Unit shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

2.5 DAVIT CRANE

A. Material lift crane
1. Load Capacity: 1200 lbs with boom fully retracted / 550 lbs with boom extended
2. Design Factor: Exceeding 3:1 for all components in all boom positions
3. Proof Testing: Tested by manufacturer to 125% of rated load
4. Hook Reach: 36"-66"
5. Height Adjustments: Infinitely adjustable from horizontal to 45 degrees
6. Boom Sheave: Sheave at end of boom that cable shall pass over
7. Height Clearance: Minimum 26 1/8" between mounting surface and underside of boom socket base. Minimum clearance of 39 ¾" between mounting surface and underside of boom-pedestal base.
8. Rotation: Freely rotate 360 degrees in mounting base
9. Pins: Zinc plated clevis style pins
10. Portability: Ability to be completely assembled and dis-assembled without tools
11. Winch Mounting: Dedicated winch mounting surface located on the top of the boom to accept either a manual or electric winch.
12. ID Tag; Labeled with a metal identification plate permanently attached, marked in such a way as to be free of corrosion or marking degradation, and to include manufacturer's name, serial number, model number, load capacity, contact information and other pertinent information.
13. Bases: Utilize purpose built pedestal, socket and wall bases, not those of universal design.
14. Bearing Surface: base shall have a self-lubricating nylon bearing sleeve to support mast rotation while also having a pin at the bottom of the base to positively engage the base of the mast.
15. Finish: Domestically made from steel meeting ASTM standards, finished in corrosion resistant zinc plating.
16. Winches: Manual winch
    (a) Brake wince type, utilizing a Weston style load holding brake
    (b) Quick-disconnect removable handle

(c) Bronze bearings
(d) Drill driven option
(e) Load capacity to be appropriately sized to match that of davit crane
(f) Finish: all metal parts, zinc plated
(g) Cable Attachment: facilitate cable attachment via either a standard cable anchor clamp, or a ball swagged cable end fitting.

B. Manufacturers:
1. OZ Lifting Products
2. Diversified Fall Protection, LTD.
3. Flexible Lifeline Systems

C. Products – At conditions with 42” or higher parapet wall:

1. OZ Lifting Products: OZTP 1200 DAV w/OZWALL1-TP Base – (Basis of Design)

D. Products – At conditions with no parapet, or parapets less than 42” in height:
Provide ballasted guards at roof davit crane locations without 42” high parapet wall

1. OZ Lifting Products: OZTP 1200 DAV w/OZPED1-TP Base (Basis of Design)

2.6 FALL ARREST SYSTEMS

A. Vertical Height Access Ladder System Kit – Channel Lifeline System for Fixed Ladders:

1. Manufacturer: Honeywell Industrial Safety (Basis of Design)
2. Model: Universal II Glide Loc System (or system length as required)
3. Provide complete system, sized to match ladder design conditions, include GlideLoc rail, end stops, ladder attachment brackets, hardware and all accessories required for complete installation. Ensure two (2) cable sleeves are provided at each ladder.
4. For Roof Access Ladders where indicated in the Drawings.
5. Approved vendors:

(h) Flexible Lifeline Solutions; 2437 Peyton Rd, Houston, TX 77032
(i) Safety Rail Company, LLC; 4244 Shoreline Drive, Spring Park, MN 55384
(j) Tritech Fall Protection; 8100 Chancellor Drive, Suite 165, Orlando, FL 32809

A. Skylight Guards (Passive Fall Protection)

1. Description: Domed Surface-Mount Skylight Guard
2. Model: ScreenGuard Skylight Protection System.
3. Size: As required.
4. Locations: Where indicated in the Drawings.
5. Manufacturers:

(a) Flexible Lifeline Solutions: Model STS-4896 G (basis of design)
(b) Safety Rail Company, LLC: Model SRC
(c) Diversified Fall Protection, LTD: Model A-SM1 Fallguard

B. Fall Protection Railings:

1. Description: Non-penetrating, free standing rooftop guardrail fall protection systems
2. Manufacturer: Safety Rail Company LLC
3. Model: Accu-fit Safety Railing – Architectural Series
4. Color: Powercoat option to match adjacent roof coping
5. Size: As required.
6. Locations: Where indicated in the Drawings.

2.7 PERIMETER SYSTEMS

A. Flag Line System
1. Ballasted base units (non penetrating); as required for design windloads, spaced MAX 30’-0” OC
2. Posts: MIN 12GA X 1.25” diameter galvanized posts
3. Cable: Safety Yellow jacket aircraft cable 1/8” diameter installed at +42” on post, with MIN 34” H / MAX 39” H cable sag
4. Provide aluminum/DFP safety yellow warning flags MAX 6’-0” OC
5. Locations: Where indicated in the Drawings.
6. Provide counterweights and/or returns as required by vendor at corners and ends of runs.
7. Approved vendors:

(a) Flexible Lifeline Solutions: Model Kee Mark – Free Standing, non-roof penetrating warning line
(b) Safety Rail Company, LLC: Model – SRC Enduraline Mobile Warning Line System
(c) Tritech Fall Protection: Custom Warning Line System

B. Ballasted Guard / Mid-Rail System

1. Ballasted base units (non penetrating): as required for design windloads
2. Posts and Rails: MIN 12GA x 1.5” galvanized
3. Top Rail: mounted at +42”
4. Mid Rail: mounted at +21”
5. Gate: Same material as railing; automatic closing with latch.
6. Finish: Manufacturer's standard safety yellow.
7. Mounting hardware: Provide all mounting hardware / connections required
8. Approved vendors:

(a) Flexible Lifeline Solutions; Kee Guard – Free Standing, non-roof penetrating guardrail
(b) Safety Rail Company, LLC; SRC Mobile Safety Rail System
(c) Tritech Fall Protection; Custom Guard / Mid-Rail System

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing weather integrity.

B. Apply bituminous paint on surfaces of units in contact with cementitious materials or dissimilar metals.

C. Adjust hinges for smooth operation.

D. Secure telescoping safety post to top two rungs of access ladder.

END OF SECTION 077220

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 078446 - Fire-Resistive Joint Systems
   a. for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.2 ACTION SUBMITTALS – NOT USED

1.3 INFORMATIONAL SUBMITTALS – NOT USED

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

   a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
   b. Classification markings on penetration firestopping correspond to designations listed by the following:

      1) UL in its "Fire Resistance Directory."

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.6 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Hilti, Inc.
2. Nelson Firestop Products.
3. 3M Fire Protection Products.
4. Tremco, Inc.; Tremco Fire Protection Systems Group.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire- resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

a. Slag-wool-fiber or rock-wool-fiber insulation.
b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
c. Fire-rated form board.
d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

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

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints at exterior curtainwall / floor intersections.
3. Joints in smoke barriers.

B. Related Sections:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 078413 - Penetration Firestopping
   a. for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.

1.2 SUBMITTALS – NOT USED

1.3 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:

1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.

2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:

   a. Fire-resistive joint system products bear classification marking of qualified testing agency.
   b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:

      1) UL in its "Fire Resistance Directory."

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.5 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa) or ASTM E 2307.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft (0.00775 cu. m/s x m) of joint at 0.30 inch wg (74.7 Pa) at both ambient and elevated temperatures.

E. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.

5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

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

B. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.

C. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078466

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Latex joint sealants.
4. Acoustical joint sealants.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 078413 – Penetration Firestopping.
3. Section 078466 – Fire Resistive Joint Systems
4. Section 092900 - Gypsum Board
   a. for sealing perimeter joints.
5. Section 093000 – Tiling
   a. for sealing tile joints.

1.2 QUALITY ASSURANCE:

A. Standards: comply with ASTM C 920 requirements.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

1.3 PROJECT 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.
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.

1.4 WARRANTY:

A. Special Installer's Warranty: Manufacturer's standard form in which 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's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those 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 structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural 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 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. Stain-Test-Response Characteristics: Where sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

D. Colors of Exposed Joint Sealants: Match adjacent surface color.

2.2 MATERIALS

A. Polyurethane Sealants: Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT

1. Tremco Commercial Sealants; “Dymonic FC” one component, fast skinning, low modulus polyurethane.
2. Tremco Commercial Sealants; “Dymeric 240 FC” multi component, gun grade, chemically curing, tintable fast setting polyurethane sealant.
3. Pecora Corporation, Dynatrol II.

B. Silicone sealants: General Electric Silicones, (800) 295-2392, internet - www.gesilicones.com

1. “SCS1700 Sanitary - Mold/Mildew Resistant Silicone”, one component 100% silicone, fungicidal based sealant.
2. “SCS2700 Silipruf Silicone” one component medium modulus, natural cure silicone all purpose sealant.
3. “Siligaze II SCS2800 - Glazing Sealant” one component, 100% silicone based sealer.
4. “GE Paintable Silicone” one component paintable silicone.
5. “DOW 795” - one component, medium modulus, natural cure silicone.

C. Latex Sealants: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Building Systems; Sonolac.
b. Bostik, Inc.; Chem-Calk 600.
c. Pecora Corporation; AC-20+.
d. Tremco Incorporated; Tremflex 834.

D. Acoustic sealants: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; AC-20 FTR.
b. USG Corporation; SHEETROCK Acoustical Sealant.

2.3 JOINT BACKING

A. General: Provide sealant backings of material that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are 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), Type O (open-cell material), Type B (bicellular 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.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

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: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.

B. 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:

1. Metal.
2. Glass.
3. Porcelain enamel.
4. Glazed surfaces of ceramic tile.

C. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. 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.

D. 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 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.

E. Tooling of Nonsag 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.

F. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 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.

3.5 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 and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

PART 4 - SCHEDULE

4.1 SCHEDULE

A. Exterior joints: Provide a continuous bead of urethane sealant and backer rod at the following vertical surfaces and horizontal nontraffic surfaces locations:

1. Hollow metal door frame perimeter
2. Brick/stone control joints
3. Sidewalk/concrete expansion joints
4. Aluminum frame perimeters
5. Perimeter joints between materials
6. Other joints as indicated in the Drawings.
7. Colors to match adjacent surfaces

B. Interior Joints (Latex Sealant) in vertical surfaces and horizontal nontraffic surfaces:

1. Control and expansion joints on exposed interior surfaces of exterior walls.
2. Perimeter joints of exterior openings where indicated.
3. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
4. Other joints as indicated in the Drawings.

C. Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces:

1. Joints between plumbing fixtures and adjoining walls, floors, and counters.
2. Other joints as indicated in the Drawings.

D. Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces:

1. Acoustical joints where indicated.
2. Other joints as indicated in the Drawings.

E. Weather barrier sealants:

1. Provide sealants that comply with ASTM C920, elastomeric polymer sealant to maintain watertight conditions

2. Products:

a. Tremco 830
b. Tremco Butyl
c. Sealants recommended by the weather barrier manufacturer.

END OF SECTION 079200

SECTION 080800 - COMMISSIONING OF OPENINGS

PART 1 GENERAL

2.01 SUMMARY

A. See Section 019113 - General Commissioning Requirements for Contractor's commissioning responsibilities and Commissioning Scope of Work, including a list of systems to be commissioned. Comply with requirements of Section 019113.

B. The Commissioning Authority (3PCx) directs and coordinates all commissioning activities as described in Section 019113.

2.02 RELATED REQUIREMENTS

A. Section 019113 - General Commissioning Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

4.01 OPERATION AND MAINTENANCE MANUALS

A. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

B. See Section 017800 for additional requirements.

END OF SECTION

SECTION 081113 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-fire-rated hollow metal doors and frames.
2. Fire-rated hollow metal doors and frames.
3. Thermally insulated hollow metal doors with frames.
4. Hollow metal borrowed lites glazing frames.

B. Related Requirements:

1. Section 087100 - Door Hardware.
2. Section 088000 – Glazing
3. Section 099000 – Paints and Coatings

1.2 REFERENCE STANDARDS

A. All work shall conform to all ordinances and regulations of the City, County, State and/or other authorities having jurisdiction.

B. ADA Standards - Americans With Disabilities Act (ADA) Standards For Accessible Design; 2010.

C. ANSI/ICC A117.1 - American National Standard for Accessible And Usable Buildings And Facilities; International Code Council; 2009.

D. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria For Physical Endurance For Steel Doors, Frames and Frame Anchors; 2011.

E. ANSI/SDI A250.8 - Specifications For Standard Steel Doors And Frames (SDI-100); 2014.

F. ANSI/SDI A250.10 - Test Procedure And Acceptance Criteria For Prime Painted Steel Surfaces For Steel Doors And Frames; 2011.

G. ASTM A653/A653M - Standard Specification For Steel Sheet, Zinc-Coated (Galvanized) Or Zinc- Iron Alloy-Coated (Galvannealed) By The Hot-Dip Process; 2015.

H. ASTM A1008/A1008M - Standard Specification For Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, And High-Strength Low-Alloy With Improved Formability, Solution Hardened, And Bake Hardenable; 2015.

I. ASTM A1011/A1011M - Standard Specification For Steel, Sheet And Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy With Improved Formability, And Ultra-High Strength; 2014.

J. BHMA A156.115 - American National Standard For Hardware Preparation In Steel Doors And Steel Frames; 2014 (ANSI/BHMA A156.115).

K. ICC A117.1 - Accessible And Usable Buildings And Facilities; International Code Council; 2009 (ANSI).

L. ITS (DIR) - Directory Of Listed Products; Intertek Testing Services Na, Inc.; Current edition.

M. NAAMM HMMA 830 - Hardware Selection For Hollow Metal Doors And Frames; 2002.

N. NAAMM HMMA 831 - Hardware Locations For Hollow Metal Doors And Frames; 2011.

O. NFPA 80 - Standard For Fire Doors And Other Opening Protectives; 2016.

P. NFPA 252 - Standard Methods Of Fire Tests Of Door Assemblies; 2012.

Q. UL (BMD) - Building Materials Directory; Current edition.

R. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

S. Tenant Global Design Guidelines (Security)

1.3 DELIVERY, STORAGE, AND HANDLING

A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

1.4 SUSTAINABLE DOOR AND FRAME SELECTION

A. Low GWP materials, with low VOC finished, as indicated by the EPDs, shall be preferred, provided they meet the specified requirements and performance criteria.

B. Contractors shall seek out suppliers that offer environmentally responsible products and materials, promoting sustainability and energy efficiency goals.

1.5 ENVIRONMENTAL CONSIDERATIONS

A. From January 1, 2024, all materials specified and used within Division 08 shall be accompanied by Environmental Product Declarations (EPDs) that conform to recognized industry standards, such as ISO 14025 and EN 15804.

B. The EPDs shall provide transparent and quantifiable data regarding the environmental impact of the materials, including but not limited to Global Warming Potential (GWP), embodies energy, resource depletion, and emissions.

C. The EPDs shall be prepared by independent third-party organizations or certified professionals experienced in life cycle assessments and environmental declarations.

D. When EPDs are available, materials with the lowest Global Warming Potential (GWP) values, as indicated by the EPDs, shall be preferred, provided they meet the project requirements and performance criteria specified within Division 08.

E. For products without available EPDs as of the effective date of this specification, acceptable alternatives with low environmental impact, as approved by the Architect/Engineer, shall be provided.

F. The Contractor shall submit the EPDs for review and approval by the Architect/Engineer during the submittal process. The approved EPDs shall be included in the project documentation and made available for reference during construction and operation phases.

G. Exceptions to this requirement may be granted by the Architect/Engineer in cases where specific materials or conditions prevent compliance. However, such expectations shall be justified in writing and approved by the Tenant.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Hollow metal doors and frames:

1. D. H. Pace: www.dhpace.com

    a. DH Pace Security Solutions
    Phone: 888-643-3667
    1901 E. 119th St.
    Olathe, KS 66061

2. Curries, an Assa Abloy Group Company: www.assaabloydss.com
3. Republic Doors: www.republicdoor.com
4. Pioneer Doors; product: www.pioneer.com
5. Steelcraft, an Allegion Brand: www.allegion.com/us

2.2 DESIGN CRITERIA

A. Requirements for hollow metal doors and frames:

1. Steel used for fabrication of doors and frames shall comply with one or more of the following requirements; galvannealed steel conforming to ASTM A653/A653M, cold-rolled steel conforming to ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel conforming to ASTM A1011/A1011M, commercial steel (CS) type B for each.
2. Accessibility: Comply with ICC A117.1 and ADA standards.
3. Hardware preparations, selections and locations: comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA a156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
4. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
5. Typical Door Face Sheets: Flush.
6. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturers standard.
7. Finish: Factory primed, for field finishing.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

C. Combined requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.3 HOLLOW METAL DOORS

A. General: (Interior)

1. SDI level 3 minimum in high traffic areas (level 2 in all other low traffic areas.) Face sheets are to be made of commercial quality 16 gauge cold rolled steel that complies with ASTM A366 or 620.
2. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless (18 gage). No visible seams permitted.
3. Core Material: Manufacturers standard core material/construction and in compliance with requirements.
4. Door Thickness: 1-3/4 inch nominal.

B. Exterior Doors: Thermally Insulated.

1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless (16 gage). No visible seams permitted.
2. Core: Polystyrene foam.
3. Door Thickness: 1-3/4 inch, nominal.
4. Top Caps: Flush with top of faces and edges.
5. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness.
6. Insulating Value: U-value of 0.50, when tested in accordance with ASTM C1363 .
7. Weatherstripping: Refer to Section 087100.
8. Wind Load Design: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
    a. Design wind speed: Design Wind Speed: Vult=135mph (Ultimate), Vasd=105mph (nominal). Loading shown on Structural Drawings where applicable.

C. Fire-rated doors:

1. Based on SDI standards: ANSI/SDI A250.8 (SDI-100).

a. Level 3 - extra heavy-duty.
b. ANSI A250.8 Level 2, physical performance Level A, Model 2, seamless (16 gage). No visible seams permitted
c. Physical performance level a, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
d. Model 1 - full flush.
e. Door face metal thickness: 16 gage, 0.052 inch, minimum.

2. Based on SDI standards: ANSI/SDI A250.8 (SDI-100).

f. Level 2 - heavy-duty.
g. ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless (18 gage). No visible seams permitted
h. Physical performance level a, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
i. Model 1 - full flush.
j. Door face metal thickness: 18 gage, 0.042 inch, minimum.

3. Fire rating: As indicated on door schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").

a. Provide units listed and labeled by UL (DIR) or its (DIR).
b. Attach fire rating label to each fire rated unit.

4. Core material: Manufacturers standard core material/construction in compliance with requirements.
5. Door thickness: 1-3/4 inch, nominal.
6. Thickness: 1-3/4 inches.

D. Interior smoke and draft control doors (indicated as "S" on drawings): same fire rated construction as the fire-rated doors.

E. Door finish: Factory primed and field finished.

2.4 HOLLOW METAL FRAMES

A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

B. General:

1. Comply with the requirements of grade specified for corresponding door.

a. ANSI A250.8 Level 2 Doors: 16 gage frames.

2. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.

C. Exterior Door Frames:

1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
2. Type: Full profile Knocked down

3. Weatherstripping: Separate, see Section 087100.

D. Interior Door Frames, Non-Fire-Rated: Full profile Knocked down

E. Interior Door Frames, Fire-Rated: Full profile Knocked down

1. Fire Rating: Same as door, labeled.

F. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.

2.5 ACCESSORIES

A. Louvers: Roll formed steel with overlapping frame; finish same as door components; factory-installed.

1. In Fire-Rated Doors: UL (BMD) or ITS (DIR) listed fusible link louver, same rating as door.

B. Glazing: As specified in Section 088000, factory installed.

C. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.

D. Astragals for double doors: Specified in section 087100.

E. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.

F. Temporary frame spreaders: Provide for factory- or shop-assembled frames.

2.6 FINISHES

A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

C. Verify that finished walls are in plane to ensure proper door alignment.

3.2 PREPARATION

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.3 INSTALLATION

A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.

B. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.

C. Frames in stud walls: Door frames in stud walls shall have a minimum of three anchors on each side, attached to double studs that extend full height of wall. Door frames shall be securely anchored to the floor.

D. Install all door and frames in accordance with ANSI/SDI A250.8-2003 (R2008)

E. Install fire rated units in accordance with NFPA 80.

F. Coordinate frame anchor placement with wall construction.

G. Coordinate installation of hardware.

H. Coordinate installation of glazing.

I. Coordinate installation of electrical connections to electrical hardware items.

J. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

3.4 TOLERANCES

A. Maximum diagonal distortion: 1/16 in measured with straight edge, corner to corner.

B. Clearances Between Door and Frame: Comply with related requirements of specified door and frame standards or custom guidelines indicated.

3.5 ADJUSTING

A. Adjust for smooth and balanced door movement.

B. Fill all dents, holes, etc. with metal filler and sand smooth and flush with adjacent surfaces - Paint to match finish.

C. Remove dirt and excess sealants, mortar, or glazing compounds from exposed surfaces.

3.6 SCHEDULE

A. Refer to door and frame schedule on the drawings.

END OF SECTION 081113

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Secton Includes:

1. Fire-rated and non-rated access doors and frames for walls and ceilings.

B. Related Requirements:

1. Section 092116 - Gypsum Board Assemblies: Openings in gypsum board ceilings.
2. Section 099000 - Paints and Coatings: Field paint finish.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. ASTM International (ASTM):

1. ASTM A 653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM A 879 - Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
3. ASTM A 1008 - Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
4. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

C. National Fire Protection Association (NFPA):

1. NFPA 80 - Fire Doors and Windows.
2. NFPA 252 - Fire Tests for Door Assemblies.

D. Underwriters Laboratories (UL):

1. UL 10B - Fire Tests of Door Assemblies.
2. UL 263 - Fire Tests Of Building Construction And Materials.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with UL requirements.

B. Fire-Rated Access Doors and Frames: Provide units complying with NFPA 80 that are identical to assemblies tested for fire-test-response characteristics per 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 vertical access doors and frames.
2. ASTM E 119 or UL 263 for horizontal access doors and frames.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide access doors by one of the following manufacturers:

1. Milcor, Inc (Commercial Products Group) Bensenville, IL; Contact Don Fessendon (630) 595-7320.
2. Acudor Products, Inc., Fairfield, NJ. (800) 722-0501.
3. Nystrom Building Products, Minneapolis, MN. (800) 547-2635 or (612) 781-7850.

2.2 STEEL MATERIALS

A. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A 879 with cold-rolled steel sheet substrate complying with ASTM A 1008, Commercial Steel (CS), exposed.

B. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS) with A60 zinc-iron-alloy (galvannealed) coating or G60 mill-phosphatized zinc coating.

C. Drywall Beads: 0.0299-inch zinc-coated steel sheet to receive joint compound.

D. Manufacturer's standard finish factory primed finish.

2.3 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Flush Access Doors and Frames:

1. Fabricated from steel sheet
2. Exposed Trim Type:

a. Model NT by Nystrom.
b. Model M 3202 by Milcor.
c. Model UF 5000 by Acudor.

3. Trimless Frame:

a. Model MW by Nystrom.
b. Model DW 3203 by Milcor.
c. Model DW 5040 by Acudor.

4. Locations: Wall and ceiling.
5. Door: Minimum 0.060-inch- thick sheet metal.
6. Frame: Minimum 0.060-inch- thick sheet metal with 1-1/4-inch- wide, surface-mounted trim.
7. Hinges: Spring-loaded, concealed-pin type or continuous piano.
8. Latch: Cam latch with interior release. Provide latch for all units unless specified to have locks.
9. Lock: Cylinder with 2 keys. Provide lockable cylinders as follows:
10. Exterior locations.
11. Units larger than 24 inches on the hinge side shall have two locks or latches.

B. Fire-rated, Insulated, Flush Access Doors and Frames:

1. Fabricated from steel sheet

2. Exposed Trim or Trimless Type:

a. Model IT or IW by Nystrom
b. Model UFR 3218 by Milcor.
c. Model FW 5050 by Acudor.

3. Locations: Wall and ceiling surfaces.
4. Fire-Resistance Rating: Not less than that of adjacent construction.
5. Temperature Rise Rating: 250 deg F at the end of 30 minutes.
6. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch.
7. Frame: Minimum 0.060-inch- thick sheet metal with 1-inch- wide, surface-mounted trim.
8. Hinges: Concealed-pin type or continuous piano.
9. Automatic Closer: Spring type.
10. Latch: Self-latching device operated with interior release.
11. Size: Minimum 24 x 36 inches except where otherwise shown on the drawings.

C. Trash Chute Door: Coordinate size of trash chute access door with trash compactor vendor.

D. Substitutions: Not Permitted.

2.4 FINISH

A. Base Metal Protection: Factory prime coat units with electrostatic baked on electrostatic powder. For ceiling units, prime exposed edges with coat of white rust-inhibitive paint.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify rough openings for door and frame are correctly sized and located.

B. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install units plumb, square and flush with adjacent ceiling or wall surface. Secure rigidly in place.

C. Position to provide convenient access to concealed work requiring access.

D. Provide weather tight installation at exterior locations

3.3 ACCESS DOOR SCHEDULE

A. Provide access door and frame suitable for the application.

B. Install trimless access door and frame in interior gypsum board walls and ceilings and other locations suitable and adaptable for trimless installation

C. Install exposed trim access door and frame where at exterior locations and where impractical to install trimless installation.

D. Install access doors in ceilings and walls in locations as shown on the Drawings, at valves, controls, and manual dampers requiring access, and as required by code and governing authorities.

END OF SECTION 083113

SECTION 083300 - IMPACT DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes traffic doors.

1.2 RELATED REQUIREMENTS

A. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.3 SUBMITTALS – NOT USED

1.4 QUALITY ASSURANCE

A. Installer qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this project.

1.5 PROJECT CONDITIONS

A. Field measurements: Verify actual dimensions of openings to receive traffic doors by field measurements before fabrication.

1.6 SUBSTITUTIONS

A. No substitutions allowed

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Chase Doors (basis of design)
2. Mueller Door Corporation.

2.2 MATERIALS

A. ABS plastic: 5,400 psi tensile strength.

B. Polycarbonate plastic sheet: ASTM D 6098, S-PC01, class 1 or 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft-lbf/in. of notch when tested according to ASTM D 256, test method A.

C. Extruded bars, rods, profiles, and tubes: ASTM B 221.

D. Sheet and plate: ASTM B 209.

2.3 TRAFFIC DOOR.

A. General: Provide manufacturer's standard factory-glazed traffic doors including accessories required for a complete installation.

B. Door panel: 1/2 inch thick ABS plastic.

C. Color: Black

D. Windows: Flush 1/4 inch thick polycarbonate, single glazed in rubber gasket with radiused corners.

E. Bumpers: Tear drop shaped on each side of door(s).

F. Sweeps: Provide sweeps at bottom of doors

G. Gaskets: Provide gaskets at jambs to seal gaps in closed position

2.4 HARDWARE

A. General: Provide units in sizes and types recommended by traffic door and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.

2.5 FABRICATION

A. General: Factory fabricate traffic door components to designs, sizes, and thicknesses indicated and to comply with indicated standards.

B. Fabricate aluminum components before finishing.

C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

D. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk phillips flat-head machine screws, finished to match framing.

E. Where fasteners are subject to loosening or turning out from structural movements or vibration, use self-locking devices.

F. Reinforce members as required to receive fastener threads.

G. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

H. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

I. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "glazing manual."

J. Hardware: Factory install hardware to the greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at project site. Cut, drill, and tap for factory-installed hardware before applying finishes.

2.6 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "metal finishes manual for architectural and metal products" for recommendations for applying and designating finishes.

B. Appearance of finished work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of traffic doors.

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

3.2 INSTALLATION

A. Install traffic doors according to manufacturer's instructions. Install doors plumb and true in alignment with established lines and grades without warp or rack. Anchor securely in place.

B. Install surface-mounted hardware using concealed fasteners to greatest extent possible.

3.3 ADJUSTING

A. Adjust operating hardware and moving parts for smooth and safe operation; lubricate as recommended by manufacturer.

B. Adjust force to open swing panels.

3.4 CLEANING AND PROTECTION

A. Clean acrylic and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.

END OF SECTION 083300

SECTION 083613 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated, insulated, steel sectional overhead doors.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 079200 - Joint Sealants: Installation of sealant at frame perimeter.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. American National Standards Institute (ANSI):

1. ANSI Z97.1 - For Safety Glazing Materials Used In Buildings - Safety Performance Specifications And Methods Of Test.

C. ASTM International (ASTM):

1. ASTM A 653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM C 1048 - Heat-Treated Flat Glass - Kind HS, Kind FT Coated And Uncoated Glass
3. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

D. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI)

1. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures

E. Door and Access Systems Manufacturer’s Association International (DASMA)

1. DASMA 102 - Sectional Overhead-Type Doors
2. DASMA 108 - Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

1.3 SUBMITTALS

A. Submittal Process: Submit in accordance with Section 013300 - Submittal Procedures.

1. Product Data: Submit Product Data sheets for each type door showing compliance with the specified physical properties.
2. Shop Drawings: For each type door installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work including details and attachment of steel door track guards.

3. Certification: Copy of signed Certified Statement from manufacturer showing door schedule of doors listing each door, by door number, provided with the following information:

   a. Door model number.
   b. Door type (aluminum or steel).
   c. Design windload values shown on drawings, manufacturer's tested windload value of door and calculated design windload for each specific door location shown on drawings.
   d. Description of modifications, if any, to the specified door model to meet windload conditions.
   e. Window size and glazing material, if applicable.

1.4 PERFORMANCE REQUIREMENTS

A. Sectional doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.

B. Structural Performance: Provide doors designed to sustain wind load pressures shown on the drawings as calculated by the manufacturer in accordance with ASCE/SEI 7. Exterior sectional doors shall withstand the effects of gravity loads, and the loads and stresses within limits and under conditions, locations, and door sizes indicated when tested in accordance with ASTM E 330 or DASMA 108.

C. Doors shall withstand design wind loads without evidencing deformation or disengagement of door components, shall remain in the opening throughout the duration of the test, and shall be deemed fully operable at the conclusion of the test in accordance with test standards specified above.

D. Operation: Manual rope lift for doors unless otherwise specified. Lift operating styles with track and hardware as indicated.

1.5 QUALITY ASSURANCE

A. Installation shall be by manufacturer's qualified and authorized installers. Installation by unauthorized installers will not be accepted.

B. Standard for Sectional Doors: Fabricate sectional doors to comply with DASMA 102 unless otherwise indicated.

1.6 DELIVERY, STORAGE AND HANDLING

A. Product Packaging: Deliver Overhead doors in manufacturer's original packaging with identification markings on each component or package.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Steel and Aluminum Sectional Overhead Doors:

   1. Overhead Door Corporation, Lewisville, TX, (800) 972-1730.

2.2 STEEL SECTIONAL OVERHEAD DOORS

A. Model:

1. Series 591 Insulated Doors

B. Components:

1. Steel Door Sections: Ribbed and textured profile, minimum 0.015 inch thick structural quality carbon steel (interior and exterior face) G60 galvanized in accordance with ASTM A 653.

a. Panel Thickness: 1-5/8 inch min.

2. Tracks, Supports, and Accessories: 3 inch track, galvanized, with leaf bumpers (stops), ball bearing roller guides, brackets, bracing, and reinforcing. Track arrangement shall be as indicated on Drawings.
3. Weather Seals: EPDM rubber bulb-type at head, jambs, and door bottoms.
4. Counterbalance: 25,000 cycle torsion spring mechanism for manual operation.
5. Lock: Interior mounted slide.
6. Hardware: Chrome plated or galvanized.
7. Insulation: CFC Free and HCFC Free Polyurethane, fully encapsulated
8. Thermal Values: R-Value of 14.6, U-value of 0.067.
9. Air Infiltration: 0.08 cfm at 15 mph; 0.08cfm at 25 mph.
10. Vision Panels: Clear thermal pane acrylic insulating glazing set into rubber or neoprene glazing channels, or plastic frames for metal door sections. Locate where indicated on Drawings.
11. Door Viewer: Ives Model 700 or equivalent by other manufacturers. Provide where scheduled.
12. Hoist: Manual rope lift.
13. Rollers: Heavy duty with steel ball bearings in case hardened stall races.

C. Fabrication:

1. Fabricate door sections not more than 24 inches high, with horizontal meeting edges rolled to form weather seal.
2. Enclose ends and provide reinforcing required for stability.

D. Anchorage Devices: Hilti HYL50 adhesive anchors 3/8”x 3-1/2” embedded rod minimum.

E. Factory Finish:

1. Two coat, baked-on polyester factory finish, exterior and interior faces.
2. Color:

a. Exterior Face: As shown on the drawings.
b. Interior Face: Manufacturer’s standard “White”.

F. Substitutions: Reference Section 012500 – Substitution Procedures

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates receiving attachments. Verify opening sizes, tolerances, reinforcements, and conditions are acceptable. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate construction of door openings within walls. Verify door head is parallel to floor.

B. Coordinate installation and locations of structural supports for door assembly.

3.3 INSTALLATION

A. Install doors in accordance with manufacturer's published instructions.

1. Stockroom/Receiving Doors: Position stops so bottom edge of door is minimum of 12 inches above top of masonry opening when door is in up position.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Fit and align assembly including hardware, level and plumb, to provide smooth operation.

D. Grout concrete masonry unit cells for attachment of track and counterbalance mechanism.

E. Install metal fabrications for support and attachment of door assembly, where required.

F. Install sealants at joints around frames and tracks as specified in Section 079200.

END OF SECTION 083613

SECTION 083615 – HIGH SPEED ROLL UP DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Overhead coiling motor operated interior and exterior non-fire rated doors.
   2. High speed fabric overhead coiling motor operated interior non-fire rated doors.
      a. Includes audio and visual alarm and countdown timers
   3. High speed aluminum overhead coiling motor operated exterior non-fire rated doors.

B. Related Requirements:
   1. Section 055000 - Metal Fabrications: Miscellaneous concealed structural support for overhead coiling door.
   2. Section 079200 - Joint Sealants: Installation of sealant at visible joints around frames and tracks.
   3. Section 099000 - Painting and Coating: Application of field paint finish.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance, Exterior Overhead Coiling Doors: Doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
   1. Design doors to sustain wind load pressures shown on the Drawings as calculated by the manufacturer in accordance with ASCE/SEI 7. Exterior coiling doors shall withstand the effects of gravity loads, and the loads and stresses within limits and under conditions, locations, and door sizes indicated when tested in accordance with ASTM E 330 or DASMA 108.
   2. Design doors to withstand design wind loads without evidencing deformation or disengagement of door components, shall remain in the opening throughout the duration of the test, and shall be deemed fully operable at the conclusion of the test in accordance with test standards specified above.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall be by a manufacturer's authorized representative or distributor who is trained and approved for both installation and maintenance of units required for this Project.

1.4 DELIVERY, STORAGE AND HANDLING

A. Product Packaging: Overhead coiling doors shall be delivered in manufacturer's standard packaging with identification markings on each component or package.

B. Transport, handle, store, and protect products in accordance with Section 016000 - Product Requirements.

1.5 SUBMITTALS

A. Florida Product Approvals: For products, components and assemblies for which Florida product approval is specified, submit Miami-Dade County NOA or Florida Building Control product approval showing compliance with the requirements of the Florida Building Code.

PART 2 - PRODUCTS

2.1 Sectional Doors

A. Sectional Steel Doors

1. Truck dock doors shall be 9 feet (2.74m) wide by 10 feet (3.05m) high.
2. Launch Pad doors shall be 12 feet (3.66m) wide by 10 feet (3.05m) high.
3. See Appendix Section 00 2000 for Preferred Providers.
4. Acceptable Manufacturers/models:
    a. Overhead Door Series 591
    b. Clopay Model 3717
    c. Amarr Model 2747
    d. Wayne Dalton Model Thermospan 200
    e. Substitutions not permitted unless approved by Tenant
5. All Sectional Doors shall meet or exceed the following requirements:
    a. Certified wind load as required by project
    b. R-Value 14.6, foam insulated, with weather seals at bottom, top and sides
    c. White exterior
    d. One 6-inch x 24-inch (0.15m x 0.61m) insulated window at driver's side
    e. 3-inch (76.20 mm) vertical lift tracks
    f. 25,000 cycle heavy-duty torsion springs
    g. Inside slide lock above track guard height at 54” AFF
    h. Manual operation unless otherwise required by project
6. Include handle and step plate to meet Tenant design standards as required by project.
7. Provide heavy duty track guards.
8. Provide stiffeners in door as required for design wind load. Adjust upward as required if building is designed to be partially enclosed
9. Where motorized drive-in doors are required provide Manufacturer’s recommended horsepower to suit door size, 480 volt / three phase, solenoid brake, auxiliary disconnect for manual operation, monitored/fail-safe electric safety edge. A key operated 7-pin SFIC on/off lockout assembly shall be connected at the controller and provided by GC.
10. There are to be no thresholds at the sectional doors to launch pad. The surface from the warehouse to the exterior paving is to be smooth and level (maximum 1:50 slope away from building for surface drainage). Any transition or control joints in the concrete pads are to be a maximum 1/2 -inch wide and shall not be located at the door threshold.

B. Existing Building Exception:
C. With Tenant approval, Existing Building sites may maintain existing dock door rough openings that are between 8 feet to 9 feet (2.44m to 2.74m) in width and between 9 feet to 10 feet (2.74m to 3.05m) in height. All other Design Criteria standards for the sectional steel truck dock doors (section 08 3613) and loading dock equipment (11 1300) must still be met.
D. Sectional Overhead Doors to exterior Launch Pad areas may be required; typical size 12 feet (3.66m) wide x 10 feet (3.05m) high, interior face of wall mounted. Sectional doors to interior Loading/Vehicle parking areas may also be required; typical size 12 feet (3.66m) wide x 12 feet (3.66m) high, interior face of wall mounted. Sizes to be confirmed on the design drawings.

High Speed Roll-Up Doors (non-insulated)

A. Only provide a product listed in the specifications
B. High speed fabric roll-up doors shall be 10 feet (3.05m) wide x 10 feet (3.05m) high 9or as shown on the Template Drawings), electrically operated, vertical acting, all weather, 100mil polypropylene fabric, located at exterior side of wall opening, face of wall mounted. Located along warehouse sides with canopy loading. Provide track guards on each side of door, 4 feet (1.22m) high, and prefinished Safety Yellow. Opening speed 100 inches per second. Closing speed 20 inches per second.
   1. Rite-Hite “FastTrax FSTX”
   2. Rytec “FlexTec”
   3. Overhead Door Series 993.
C. Door shall be provided with manufacturers stand variable frequency motor drive, and electronic control system with graphical user interface. Electronic control system shall provide password protected access, requiring password to modify door operational settings.
D. Door operation sensor: Provide complete door sensor controls package integrated with door manufacturer control panel.
   1. Sensor Manufacturers: Rockwell “442L-SFZNSZ with -10 Memory Module”
   2. SICK “TiM3xxS’
   3. Keyence “SZ-V04X”
   4. BEA :LZR Widescreen”
E. Provide one sensor device on each side of door as the primary door control sensor. Device shall be configured to integrate with the door manufacturers’ control system to provide a continuously monitored, "Fail Safe" door control operating system.
   1. Loadout doors (for people to enter/exit) and high-speed roll-up doors:
   2. The overhead sensor manufacturers ship the sensors to detect vehicles as the default setting (as the object type) to open the high-speed doors automatically. The overhead sensors come with 3 available settings. At each load-out door, manually change the setting to “other” to ensure the door will open automatically when the sensor detects people and smaller objects than vehicles.
   3. Install the overhead sensors above the doors and centered.
   4. On the overhead sensors, set the total motion field or field width (which is the door width) to be 144” and motion stop or field stop (the space in front of the overhead sensor) to be 84”.
   . On the door controls, set the hold open time to 4 seconds so the doors will close automatically in 4 seconds.
   6. The sensor with Lidar function is not to be installed outside unless a roof or structure is installed over the sensors to prevent sunlight from causing a false operation.
   7. Drive in/out doors (for vehicles to enter/exit) and high-speed roll-up doors:

8. On the overhead sensors, ensure the setting is to detect vehicles. The doors are not to open when detecting people at the drive in/out doors.
9. If an overhead sensor is provided on the exterior wall above the DRIVE-OUT doors, set the motion/sensor field width to zero and motion/field stop to 0. The door must open from the inside only and not from the outside when detecting a vehicle.
10. If an overhead sensor is provided on the interior wall above the DRIVE-IN doors, set the motion/ sensor field width to zero and motion/field stop to 0. The door is to open from the outside only and not from the inside.
11. On the door controls, set the hold open time to 4 seconds so the doors will close automatically in 4 seconds.
12. The sensor with Lidar function is not to be installed outside unless a roof or structure is installed over the sensors to prevent sunlight from causing a false operation.

F. Doors shall be gear driven in both ascending and descending travel of the door curtain. Doors shall descend at a maximum velocity of 20 inches/second (0.5m/s) and be provided with a bottom bar/weather seal and have a “fail safe” operating system

G. Safety requirements for door operations shall be as follows:
1. Manual Control function: Doors are manually controlled from the interface control panel, as well as by the control and safety devices as described below.
2. Motion/Safety/Presence function: Door operations are controlled by the door operation sensor, as follows:
3. Activation mode: Sensor will act as door activating device (opening upon motion detection in the door safety zone).
4. Safety mode: Sensor will act as safety device (shunt downward operation on presence detection in the door safety zone, return door to fully open position, reset timer).
5. Presence Detection mode: Sensor will act as the door safety zone presence detector (delay timed closing action of the door until no presence detection in the door safety zone).

H. Sensor shall be site configured to operate as described within the final "door safety zone" layout.

I. Provide photo-eye safety sensors in the plane of the door curtain, at +18 inches and +54 inches AFF. Interruption of the sensor beam shall shunt downward operation, requiring a reset from the control panel when the obstruction has been cleared.

J. Due to the nature of the high-speed roll-up door, it is necessary to keep this area clear when pick carts (or vehicles if the building is an interior load warehouse) are not being ushered through.

K. The following safety criteria are established for a No-Stand-Zone at these areas:
1. The Clear Zone is demarcated by painted red striping on the ground with diagonal striping in center area.
2. The Clear Zone is to be the width of the opening and 4 feet 0 inches; offset 2 feet 0 inches to both the interior and exterior of the door.
3. Provide 6-inch tall, stenciled text "STAY CLEAR" at interior and exterior edges of each zone; font of text to be Arial.
4. The Clear Zones are to be provided at all high-speed roll up door locations.

. There are to be no thresholds at the load out roll-up doors; the surface from the warehouse to the Launch pads is to be smooth and level (maximum 1:50 slope away from building for surface drainage). Any transition or control joints in the concrete pads are to be a maximum 1/2 inch (12.7mm) wide.

M. Existing Building Exception:

1. High speed roll up doors to exterior Launch Pad areas may be required; typical size 10 feet (3.66m) wide x 10 feet (3.05m) high, exterior face of wall mounted. High speed roll up doors to interior Loading areas may be required; typical size 10 feet (3.66m) wide x 10 feet (3.66m) high, exterior face of wall mounted.

2.1 INTERIOR FLEXIBLE HIGH SPEED ROLL UP DOORS – NON INSULATED

A. Flexible, high speed overhead coiling door for interior environments:

1. Approved manufacturers:
   a. FastTrax FSTX, by Rite-Hite.
      1) Josh Morgan, jmorgan@ritehite.com (253) 951-5694
   b. FlexTec, by Rytec.
      1) Chase Deaton, cdeaton@rytecdoors.com (262) 339-3890
   c. Series 993, by Overhead Door
      1) Michael Minneker, Michael_Minneker@OverheadDoor.com (469) 275-8279
2. Electronically operated;
3. Vertical acting;
4. All weather 100mil polypropylene fabric, or manufacturer's standard equivalent or greater.
5. Locate at interior side of wall opening;
6. Dimensions: As indicated on the Drawings.
7. Manufacturer's standard variable frequency motor drive, and electronic control system with graphical user interface. Electronic control system shall provide password protected access, requiring password to modify door operational settings.
8. Door Operation Sensor: Provide complete door sensor controls package integrated with door manufacturer control panel.
   a. 442L-SFZNSZ w/-10 Memory Module, by Rockwell.
   b. TiM3xxS, by SICK.
   c. SZ-V04X, by Keyence.
   d. LZR Widescan, by BEA.
      1) Provide one device on each side of door as the primary door control sensor. Device shall be configured to integrate with the door manufacturer's control system to provide a continuously monitored, "Fail Safe" door operating system.
9. Door shall be gear driven in both ascending and descending travel of door curtain.
   a. Opening Speed: 100 inches per second.
   b. Closing Speed: 20 inches per second.
10. Safety Requirements for door operations:
    a. Manufacturer to provide visual countdown timer for both sides of door.
    b. Manufacturer to provide audible alarms for door motion for both sides of door.
    c. Manual Control Function: Doors are manually controlled from the interface control panel, as well as by the control and safety devices described below.
    d. Motion/Safety/Presence Function: Door operations are controlled by the door operation sensor, as follows:
       1) Activation Mode: Sensor will act as door activating device (opening upon motion detection in the door safety zone).
       2) Safety Mode: Sensor will act as a safety device (shunt downward operation on presence detection in the door safety zone, return door to fully open position, reset closing cycle timer).

3) Presence Detection Mode: Sensor will act as the door safety zone presence detector (delay timed closing action of the door until no presence detection in the door safety zone).

e. Sensor shall be site configured to operate as described within the final “door safety zone” layout.

f. Provide photo-eye safety sensors in the plane of the door curtain, at 18” AFF and 54” AFF.

1) Interruption of the sensor beam shall shunt downward operation, requiring a reset from the control panel when the obstruction has been cleared.

2.2 EXAMINATION

A. Examine surfaces and adjacent areas. Do not proceed with Work until unsatisfactory conditions have been corrected.
1. Openings shall be to the dimensions indicated.
2. Headers shall be level and parallel with finish floor.
3. Door support framing installed at locations indicated.

2.3 PREPARATION

A. Interface with Other Work.
1. Coordinate installation and locations of structural supports for door assembly.

2.4 INSTALLATION

A. Provide openings, size as scheduled on Drawings, with head, jambs, and sill as detailed.

B. Install metal fabrications for support and attachment of door assembly. Door structural supports shall be as specified in Section 055000.

C. Install doors in accordance with manufacturer's published instructions and in accordance with NFPA 80.

D. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

E. Fit and align assembly including hardware; level and plumb to provide smooth operation.

F. Install chain keeper at each door in accordance with manufacturer’s instructions (excluding High Speed Coiling Doors).

G. Provide sealants and backing materials at frame perimeter as specified in Section 079200.

H. Field paint visible surfaces of curtain guides and framing when door is in open position as specified in Section 099000.

I. Launch Pad / Load Out Overhead Coiling Doors: There are to be no thresholds, the surface from the warehouse to the Launch pad is to be smooth and level (max. 1:50 slope away from building for surface drainage). Any transition joints in the concrete pads are to be max. ½ inch wide.

2.5 FIELD QUALITY CONTROL

A. Site Tests: Upon completion if installation, test operation of door.
   1. Make all necessary adjustments as required and retest.
   2. After acceptance of test results, re-set door to original position.

B. Inspection:
   1. Inspect overhead coiling door and operating system installation.
   2. Correct deficiencies in Work which inspection indicates are not in compliance with Contract Documents.

END OF SECTION 083323

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Exterior and interior storefront framing.
2. Storefront framing for window walls.
3. Storefront framing for ribbon walls
4. Storefront framing for punched openings.
5. Exterior and interior manual-swing entrance doors and door-frame units.

B. Related Requirements:

1. Division 01: Administrative, Procedural, And Temporary Work Requirements.
2. Section 016116 – Volatile Organic Compound (VOC) Restrictions
3. Section 079200 – Joint Sealants
4. Section 084229 – Sliding Automatic Entrances
5. Section 088000 - Glazing

1.2 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; most current

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; most current

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; most current

D. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; most current

E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; most current

F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric]; most current

G. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; most current

H. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; most current

I. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; most current

J. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; most current

K. ASTM E 1996 - Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

1.3 PERFORMANCE REQUIREMENTS

A. Delegated design: Contractor to design aluminum-framed systems.

B. Deflection of framing members:

1. Deflection normal to wall plane: Limited to L/175.
2. Deflection parallel to glazing plane: Limited to L/360 or 1/8 inch (3.2 mm), whichever is smaller.

C. Air infiltration:

1. Fixed framing and glass area: maximum air leakage of 0.60 cfm/sq. ft. (0.30 l/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 pa).

D. Entrance doors:

1. Pair of doors: maximum air leakage of 1.0 cfm/sq. ft. (5.08 l/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 pa).
2. Single doors: maximum air leakage of 0.5 cfm/sq. ft. (2.54 l/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 pa).

1.4 SUBMITTALS

A. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, internal drainage details.

B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

C. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

D. Samples: For each exposed finish required.

E. Energy performance certificates.

F. Florida Product Approvals: For products, components and assemblies for which Florida product approval is specified, submit Miami-Dade County NOA or Florida Building Control product approval showing compliance with the requirements of the Florida Building Code.

1.5 PROJECT CONDITIONS

A. Field measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on shop drawings.

B. Coordinate the work with installation of vapor retarder components or materials.

1.6 QUALITY ASSURANCE

A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the State in which the Project is located.

B. Manufacturer and Installer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum three years of documented experience.

C. Florida Building Code (FBC) Requirements:

1. Products of exterior window and door components or assemblies shall have Miami-Dade County Product Control Notice of Acceptance (NOA) or Florida Building Code (FBC) Product Approval to meet the requirements of the current Florida Building Code as necessary to obtain permits required for acceptance of work by Authorities Having Jurisdiction.
2. Labeling: Exterior windows and doors shall be labeled in accordance with the requirements of the Florida Building Code.
3. Provide exterior window and door components and assemblies approved for design pressures calculated in accordance with the Florida Building Code bearing FBC Product Approval numbers or Miami-Dade County NOA numbers for intended applications and functions of exterior assembly. Provide window and door systems tested as an assembly using components stated in product approval documents.
4. Verify acceptance of product approvals by Authorities Having Jurisdiction before fabrication or delivery. The various systems, in their fabrication and installation, shall comply with the approval acceptance criteria and supporting drawings and documentation.
5. Verify products or assemblies have product approval, that product approval numbers are valid and current, and that related construction assemblies and components are used to ensure approval by Authorities Having Jurisdiction. Where approval document numbers specified herein or associated products are not current or not otherwise applicable, notify the Architect by Request for Information (RFI) for clarification.
6. Approval criteria shall take precedence over specific product models and product requirements specified herein. Where components and characteristics associated with the approval documents differ with the requirements stated herein, the approved requirements shall govern and shall be provided.

D. Windborne-Debris Impact Resistance: Provide exterior doors and storefront framing that pass basic-protection testing requirements in ASTM E 1996 when tested according to ASTM E 1886.

1. Large-Missile Test: For glazing located within 30 feet of grade.
2. Small-Missile Test: For glazing located more than 30 feet above grade.

1.7 WARRANTY

A. The manufacturer shall warrant all equipment and appurtenances and the installation of all equipment for a period of five years from the date of acceptance.

B. Special warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
2. Structural failures including, but not limited to, excessive deflection.
3. Noise or vibration caused by thermal movements.
4. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
5. Adhesive or cohesive sealant failures.

6. Water leakage through fixed glazing and framing areas.
7. Failure of operating components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Aluminum Framed Storefront and Doors:

1. Kawneer North America: www.kawneer.com
2. C.R. Laurence Co., Inc; U.S. Aluminum: www.crl-arch.com
3. EFCO Corporation: www.efcocorp.com
4. Tubelite, Inc: www.tubeliteinc.com
5. United States Aluminum Corp: www.usalum.com
6. YKK AP America Inc: www.ykkap.com

2.2 STOREFRONT

A. Aluminum Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage, and attachment devices.
   1. Glazing Position: Centered (front to back).
   2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
   3. Finish: Clear anodized.
      a. Factory-finish all surfaces that will be exposed in completed assemblies.
   4. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
   5. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
   6. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
   7. Expansion / Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12-hour period without causing detrimental effect to system components, anchorages, and other building elements.
   8. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
   9. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Performance Requirements:

   1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.

      a. Design Wind Speed: Reference Structural Drawings.
      b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
      c. Impact Rated:

         1) Approval Document: Florida Building Code Product Approval Number

2) Approval Document: Miami-Dade County NOA Number

2. Water Penetration Resistance: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 10 psf.
3. Air Leakage: Maximum of 0.60 cu ft/min sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 psf pressure differential across assembly.
4. Provide steel reinforcement in mullions as required to meet wind load.
5. Movement: Accommodate movement between storefront and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.
6. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
7. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12-hour period without causing detrimental effect to system components, anchorages, and other building elements.

2.3 COMPONENTS

A. Aluminum Framed Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.

1. Framing members for interior applications need not be thermally broken.
2. Glazing Stops: Flush.

B. Doors: Glazed aluminum, wide stile.

1. Thickness: 1-3/4 inches.
2. Top Rail: 5 inches wide.
3. Vertical Stiles: 5 inches wide.
4. Bottom Rail: 10 inches wide.
5. Glazing Stops: Square.
6. Finish: Same as storefront.

C. Sill Pan Flashing:

1. High-Performance (HP) sill pan. Equal to Trifab 451 HP by Kawneer Company.

2.4 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Sheet Aluminum: ASTM B209 (ASTM B209M).

C. Fasteners: Stainless steel. Exposed fasteners, countersunk, finish to match aluminum color.

D. Exposed Flashings: Aluminum sheet, 20 gage, 0.032 inch minimum thickness; finish to match framing members.

E. Concealed Flashings: 0.018 inch thick galvanized steel.

F. Perimeter Sealant: Type - Silicone, specified in Section 079200.

G. Glazing and Accessories: As specified in Section 088000.

2.5 FINISHES

A. Architectural Class II Clear Anodized Finish: AAMA 611 AA-M12C22 A31, not less than 0.010 mm thick.

B. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.6 HARDWARE

A. Door hardware as indicated on the Drawings.

2.7 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

E. Arrange fasteners and attachments to conceal from view.

F. Reinforce components internally for door hardware.

G. Reinforce framing members for imposed loads.

H. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies.

I. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 08 section "Glazing."

1. Structural-sealant glazing:

a. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
b. Install weather seal sealant according to Division 07 section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

G. Entrance doors: Install doors to produce smooth operation and tight fit at contact points.

H. Exterior doors: Install to produce weathertight enclosure and tight fit at weather stripping.

1. Install perimeter joint sealants as specified in Division 07 section "Joint Sealants" to produce weathertight installation.

I. Adjusting

1. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.

3.3 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever isless.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.4 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

C. Remove excess sealant by method acceptable to sealant manufacturer.

END OF SECTION 084113

NIXEXSECTION 087100 – DOOR HARDWARE

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 PROCUREMENT

A. Vendors

1. Items covered in this section shall be provided and installed by the general contractor, unless noted otherwise on the drawings.
2. All items in this section shall be purchased by the general contractor.

1.3 SUMMARY

A. This section includes commercial door hardware for the following:

1. Swinging doors.
2. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Automatic operators.
4. Cylinders specified for doors in other sections.

C. Related Sections:

1. Door Hardware Schedule as indicated on the Drawings.
2. Section 016116 – Volatile Organic Compound (VOC) Restrictions
3. Section 081113 – Hollow Metal Doors and Frames
4. Section 084113 - Aluminum-Framed Entrances and Storefronts

D. Codes and references: Comply with the version year adopted by the authority having jurisdiction.

1. ANSI A117.1 - accessible and usable buildings and facilities.
2. ICC/IBC - international building code.
3. NFPA 70 - national electrical code.
4. NFPA 80 - fire doors and windows.
5. NFPA 101 - life safety code.
6. NFPA 105 - installation of smoke door assemblies.
7. UL/ULC and CSA C22.2 – standards for automatic door operators used on fire and smoke barrier doors and systems of doors.
8. State building codes, local amendments.

E. Standards: all hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA certified product standards - A156 series
2. UL10C – positive pressure fire tests of door assemblies

1.4 ENVIRONMENTALLY RESONSIBLE HARDWARE

A. The selection and specification of hardware within Division 08 shall consider the environmental impact, energy efficiency, and sustainability aspects of the products.

B. Where applicable, EPDs and other relevant environmental information shall be requested from hardware manufacturers of suppliers to evaluate the materials Global Warming Potential (GWP) and other environmental factors.

C. Low GWP options and environmentally certified hardware shall be preferred, as appropriate and submitted to meeting the specified requirements.

1.5 SITE VERIFICATIONS – BROWNFIELD SITES

A. Brownfield sites commonly refer to an existing warehouse facility where the tenant is renovating the building to suit their operational needs. Existing exterior door hardware will need to be surveyed and inspected to ensure that it meets tenant's security requirements. Non-compliant hardware will need to be replaced to meet tenant's current specifications. This may entail replacement of existing door / frame assembly, if required to accept the new hardware.
   1. Refer to the drawings for additional information

B. Contractor to visit the existing job site and examine existing door / frame / hardware condition and provide a survey to tenant's representative. Existing doors / frames / hardware to be free of rust and in good working order. Damaged components shall be repaired or replaced.

C. Survey existing lockset(s) or panic devices and verify that all locking hardware will accept 7-pin Small Format Interchangeable Cores (SFIC) core (refer to Section 087100 2.5). Provide new lockset(s) or panic device(s) to accept proper SFIC core if not already existing.

   1. If existing lockset or panic device within the new warehouse or office areas are required to be replaced, then provide locking hardware based on the following:
      a. For perimeter HM egress doors, refer to hardware set #4.
      b. For perimeter HM trucker's entry doors, refer to hardware set #4B.
      c. For perimeter storefront egress doors, refer to hardware set #2A
      d. At new main entry, recruiting, or staffing entry locations, the existing hardware set will need to be compatible with tenant's electronic access control system as well as incorporate panic devices compatible with the small format SFIC core.

   2. All site verifications shall be coordinated by GC to include considerations of existing door and frame preps, fire ratings, windstorm/hurricane ratings, special circumstances, and general construction timeline needs.

1.6 SUBMITTALS

A. Louisiana State Fire Marshal Submittal: GC to coordinate submittal to the LSFM for the Special Locking Arrangements

B. Product data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

C. Product test reports: Indicate compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

D. Door hardware schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format For The Hardware Schedule."
2. Organization: Organize the door hardware schedule into door hardware sets indicating complete designations of every item required for each door or opening.
3. Organize door hardware sets in same order as in the door hardware sets at the end of Part 3. Submittals that do not follow the same format and order as the door hardware sets will be rejected and subject to resubmission.
4. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

5. Submittal sequence: Submit the final door hardware schedule at earliest possible date, particularly where approval of the door hardware schedule must precede fabrication of other work that is critical in the project construction schedule. Include product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware schedule.

E. Shop drawings: Details of electrified access control hardware indicating the following, if requested:

1. Wiring diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

    a. Elevation diagram of each unique access-controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    b. Complete (risers, point-to-point) access control system block wiring diagrams.
    c. Wiring instructions for each electronic component scheduled herein.

2. Electrical coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

F. Closeout Submittals: Operating and maintenance manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

1.7 QUALITY ASSURANCE

A. Manufacturers qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this project and that have a proven record of successful in-service performance.

B. Installer qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this project and whose work has resulted in construction with a record of successful in-service performance.

C. Door hardware supplier qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this project. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the work to consult with contractor, architect, and owner concerning both standard and electromechanical door hardware.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
   1. Electrified modifications or enhancements made to a source manufacturer’s product line by a secondary or third party source will not be accepted.
   2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

E. Automatic operator supplier qualifications: Power operator products and accessories are required to be supplied and installed through current members of the manufacturer's "Power Operator Preferred Installer" program. Suppliers are to be factory trained, certified, and a direct purchaser of the specified power operators and be responsible for the installation and maintenance of the units and accessories indicated for the project.

F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

   1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
   2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
   3. Review sequence of operation narratives for each unique access-controlled opening.
   4. Review and finalize construction schedule and verify availability of materials.
   5. Review the required inspecting, testing, commissioning, and demonstration procedures.

H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.8 DELIVERY, STORAGE, AND HANDLING

A. General contractor to inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to project site. Do not store electronic access control hardware, software or accessories at project site without prior authorization.

B. Tag each item or package separately with identification related to the final door hardware schedule and include basic installation instructions with each item or package.

1.9 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door hardware and electrical connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and frame preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.10 WARRANTY

A. General warranty: Reference Division 01, General Requirements. Special warranties specified in this article shall not deprive owner of other rights owner may have under other provisions of the contract documents and shall be in addition to, and run concurrent with, other warranties made by contractor under requirements of the contract documents.

B. Warranty period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Special warranty periods:

1. Seven years for heavy duty cylindrical (bored) locks and latches.
2. Five years for exit hardware.
3. Twenty-five years for manual surface door closer bodies.
4. Five years for motorized electric latch retraction exit devices.
5. Two years for electromechanical door hardware.

1.11 MAINTENANCE SERVICE

A. Maintenance tools and instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.12 DEFINITIONS

A. The following is a general list of terms included in the specification that may require additional definitions.

1. “CLSRM” – Classroom
2. “DPS” – Door Position Switch
3. “ELEC” - Electrified
4. “ELR” – Electric Latch Release
5. “EPT” – Electronic Power Transfer
6. “NL” – Night Latch
7. “LDW” – Less Door Width – meaning nominal door width as scheduled on the door schedule.
8. “RX” – Request to Exit
9. “SFIC” – Small Format Interchangeable Corepart 1 - General

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in door hardware sets where indicated on the Drawings and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the door hardware sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named manufacturer's products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the door hardware schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Reference section 012500 – Substitution Procedure.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the door hardware sets.

1. Quantity: Provide the following hinge quantity, unless otherwise indicated:

a. Two hinges: For doors with heights up to 60 inches.
b. Three hinges: For doors with heights 61 to 90 inches.
c. Four hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’-0”: 4 ½” standard or heavy weight as specified.

b. Sizes from 3’-1” to 4’-0”: 5” standard or heavy weight as specified.

3. Hinge weight and base material: Unless otherwise indicated, provide the following:

a. Exterior doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless hardware sets indicate standard weight.
b. Interior doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless hardware sets indicate heavy weight.

4. Hinge options: Comply with the following where indicated in the hardware sets or on drawings:

a. Non-removable pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Acceptable manufacturers:

a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – TA Series.

B. Continuous Geared Hinges: ANSI_BHMA A156.26 Grade 1-600 certified continuous geared hinge with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cutouts.

1. Acceptable manufacturers:
a. Pemko Products: ASSA ABLOY Architectural Door Accessories (PE).

C. Pivots: ANSI/BHMA A156.4, Grade 1, Certified. Space intermediate pivots equally not less than 25 inches on center apart or not more than 35 inches on center for doors over 121 inches high. Pivot hinges to have oil impregnated bronze bearing in the top pivot and a radial roller and thrust bearing in the bottom pivot with the bottom pivot designed to carry the full weight of the door.

1. Acceptable manufacturers:

a. Rixson Door Controls (RF).

2.3 POWER TRANSFER DEVICES

A. Electrified quick connect transfer hinges: Provide electrified transfer hinges where scheduled with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the door hardware sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Acceptable manufacturers:

a. McKinney Products: ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) option.

B. Concealed quick connect electric power transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the door hardware sets. Connectors plug

directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Acceptable manufacturers:

    a. Pemko Products: ASSA ABLOY Architectural Door Accessories (PE) – EL-CEPT Series.
    b. Securitron (SU) – EL-CEPT Series.

C. Electric door wire harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

    a. McKinney Products: ASSA ABLOY Architectural Door Accessories (MK) - electrical connecting kit: QC-R001.
    b. McKinney Products: ASSA ABLOY Architectural Door Accessories (MK) - connector hand tool: QC-R003.

2. Acceptable manufacturers:

    a. McKinney Products: ASSA ABLOY Architectural Door Accessories (MK) – QC-C series.

D. Door cord: Provide surface applied door cord power transfers where scheduled with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the door hardware sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable. 18” cord will be standard unless scheduled otherwise.

1. Acceptable manufacturers:

    a. Keedex (KX) – Part No. K-DL38A

2.4 DOOR OPERATING TRIM

A. Flush bolts and surface bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, Certified.

1. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) As required for appropriate installation and operation.
5. Acceptable manufacturers:

    a. Rockwood Products: ASSA ABLOY Architectural Door Accessories (RO).

B. Door push plates and pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the hardware sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/pull plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 ½-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Armor plates: Minimum .050 inch thick, size as indicated in hardware sets, with 4 beveled edges, secured with exposed screws unless otherwise indicated. 30” in height.
5. Kick plates: Minimum .050 inch thick, size as indicated in hardware sets, secured with exposed screws unless otherwise indicated. 10” in height.
6. Fasteners: Provide manufacturer's designated fastener type as indicated in hardware sets.
7. Mounting: Armor and kick plates shall be mounted on the push side of an opening unless specified otherwise specifically in the hardware schedule.

1. Acceptable manufacturers:
   a. Rockwood Products: ASSA ABLOY Architectural Door Accessories (RO).

2.5 CYLINDERS AND KEYING

A. All key structures and final keying/installation of final keying will be purchased and coordinated by the owner directly. For more information contact:

1. DH Pace Security Solutions
   Attn: DH Pace Key Services Center
   Ph: 888-643-3667
   1901 E. 119th St.
   Olathe, Ks 66061

B. Construction keying: Provide temporary green SFIC keyed cores. Include 2 control keys and 15 operating keys. Installer shall confirm functionality of lock and core as part of installation.

C. All locking devices shall accommodate 7 pin small format interchangeable cores (SFIC).

D. Key control cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Acceptable manufacturers:

   a. Lund Equipment (LU).
   b. MMF Industries (MM).
   c. TelKee (TK).

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise locksets, grade 1 (heavy duty): ANSI/BHMA A156.13, Series 1000, operational grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Acceptable manufacturers:

a. Sargent Manufacturing (SA) – 8200 series.

b. no substitution.

B. Cylindrical locksets, grade 1 (heavy duty): ANSI/BMHA A156.2, series 4000, grade 1 certified cylindrical (bored) locksets furnished in the functions as specified in the hardware sets. Lock chassis fabricated of heavy gauge steel, zinc dichromate plated, with through-bolted application.

1. Furnish with solid cast levers, standard 2 3/4” backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt.
2. Locks are to be non-handed and fully field reversible.
3. Extended cycle test: Locks to have been cycle tested in accordance with ANSI/BHMA 156.2 requirements to 2 million cycles.
4. Lock trim design: As specified in the hardware sets.

5. Acceptable manufacturers:

a. Sargent Manufacturing (SA) – 10 line.

b. no substitution.

2.7 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical mortise locksets, grade 1 (heavy duty): Subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below.

1. Electrified lock options: Where indicated in the hardware sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, and request-to-exit signaling. Unless otherwise indicated, provide electrified locksets standard as fail secure.
2. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
3. Acceptable manufacturers:

a. Sargent Manufacturing (SA) - 8200 series.
b. no substitution.

B. Electromechanical cylindrical locksets, grade 1 (heavy duty): Subject to same compliance standards and requirements as mechanical cylindrical locksets, electrified locksets to be of type and design as specified below.

1. Electrified lock options: Where indicated in the hardware sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, and request-to-exit signaling. Unless otherwise indicated, provide electrified locksets standard as fail secure.

2. Acceptable manufacturers:

   a. Sargent Manufacturing (SA) – 10G70/71 series.

   b. no substitution.

2.8 STAND ALONE ACCESS CONTROL LOCKING DEVICES

A. Stand Alone Locksets: ANSI A156.2, Series 4000, Grade 1 locking mechanism complete with integrated touchscreen or keypad as specified for access and programming. Voice-guided programming with 12-digit PIN code selection and up to 1000 user option. Locks to accept standard, small format interchangeable core, security and patented cylinders. Battery-operated, with low power indicator, or hard-wired (9 Volt external power supply) option.

   1. Manufacturers:

      a. Yale Commercial(YA) - nexTouch Series.
      b. Simplex (SI) - L1000 Series.

2.9 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

   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.
   3. Aluminum-frame strike box: Provide manufacturer's special strike box fabricated for aluminum framing.
   4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

   1. Strikes for mortise locks and latches: BHMA A156.13.
   2. Strikes for bored locks and latches: BHMA A 156.2.
   3. Strikes for auxiliary deadlocks: BHMA A156.36.
   4. Dustproof strikes: BHMA A 156.16.

2.10 ELECTRIC STRIKES

A. Standard Electric Strikes: Heavy duty, cylindrical and mortise lock electric strikes conforming to ANSI/BHMA A156.31, Grade 1, UL listed for both Burglary Resistance and for use on fire rated door assemblies. Stainless steel construction tested for a minimum 1 million operating cycles. Provide strikes with 12 or 24 VDC capability and supplied standard as fail-secure unless otherwise specified. Provide latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike where specified.

   1. Acceptable manufacturers:

      a. Folger Adam EDC (FO)

      b. HES (HS)

B. Provide electric strikes with in-line power controller and surge suppressor by the same manufacturer as the strike with the combined products having a five year warranty.

2.11 CONVENTIONAL EXIT DEVICES

A. General requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "panic hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the hardware sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "fire exit hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in hardware sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is not acceptable except in any case where the door light extends behind the device as in a full glass configuration.
5. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
6. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.
7. Lever operating trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with four threaded studs for thru-bolts.

    a. Lock trim design: As indicated in hardware sets, provide finishes and designs to match that of the specified locksets. Provided free-wheeling type trim where indicated.
    b. Where function of exit device requires a cylinder, provide a cylinder (rim or mortise) as specified in hardware sets.

8. Pull operated trim: Where exit devices require pull trim, furnish manufacturer's heavy duty pull trim with thru-bolts.

    a. Trim design: As indicated in hardware sets, provide finishes and designs to match that of the designated function and pull style.
    b. Where function of exit device requires a cylinder, provide a cylinder (rim or mortise) as specified in hardware sets.

9. Vertical rod exit devices: Provide and install interior surface and concealed vertical rod exit devices as less bottom rod (LBR) unless otherwise indicated.
10. Narrow stile applications: At doors constructed with narrow stiles, or as specified in hardware sets, provide devices designed for maximum 2” wide stiles.
11. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
12. Rail sizing: Provide exit device rails factory sized for proper door width application.
13. Through bolt installation: For exit devices and trim as indicated in door hardware sets.

B. Conventional push rail exit devices (heavy duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the hardware sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature.

1. Acceptable manufacturers:
   a. Sargent Manufacturing (SA) - 80 series.
   b. Detex Corporation (DE) - Advantex
   c. no substitution.

B. Tube steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish.
1. Provide keyed removable feature where specified in the Hardware Sets.
2. Provide stabilizers and mounting brackets as required.
3. Provide electrical quick connection wiring options as specified in the hardware sets.
4. Acceptable manufacturers:

   a. Sargent Manufacturing (SA) – 980S Series
   b. No substitution.

2.12 DOOR CLOSURES

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
2. Standards: Closers to comply with UL-10C for positive pressure fire test and be UL listed for use of fire rated doors.
3. Cycle testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
4. Size of units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
5. Closer arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in hardware sets.

   a. Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.
   b. Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.
   c. Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.
   d. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics. Provide drop plates or other accessories as required for proper mounting.

6. Closer accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as specified in the door hardware sets. Provide through-bolt and security type fasteners as specified in the hardware sets.
7. Closers on gates: Gate manufacturer to prepare gates with proper reinforcements and mounting surfaces for installation of closers where scheduled. Templates for proper reinforcements shall be provided by hardware supplier for reference upon request.

B. Door closers, surface mounted (heavy duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully

operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Acceptable manufacturers:

    a. Norton Door Controls (NO) - 7500 Series.
    b. Sargent Manufacturing (SA) - 351 Series.

C. Door closers, surface mounted (Unitrol): ANSI/BHMA A 156.4, Grade 1 certified surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Unitrol arms to have door stop mechanism to absorb dead stop shock on arm and top hinge. Hold-open arms to have a spring loaded mechanism in addition to shock absorber assembly. Arms to be provided with rigid steel main arm and secondary arm lengths proportional to the door width.

1. Acceptable manufacturers:

    a. Norton Door Controls (NO) - Unitrol 7500 series.

    b. No substitution.

2.13 ELECTROHYDRAULIC DOOR OPERATORS

A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.

1. Fire-rated doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.

B. Electrohydraulic door operators: Self-contained low-pressure units with rack and pinion design contained within a cast aluminum housing. Door closing speed controlled by independent hydraulic adjustment valves in the sweep and latch range of the closing cycle. Operator is to provide conventional door closer opening and closing forces unless the power operator motor is activated. Unit is to include an adjustable hydraulic backcheck valve to cushion the door speed if opened violently. Non-handed units for both push and pull side applications.

C. Standard: Certified ANSI/BHMA A156.19.

1. Performance requirements:

    a. Opening force if power fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
    b. Entrapment protection: Not more than 15 lbf required to prevent stopped door from closing or opening.

D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.

E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle

as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.

1. On-off switch to control power to be key switch operated.

F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.

G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.

H. Brackets and reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.

I. Activation devices: Provide activation devices in accordance with ANSI/BHMA A 156.19 standard, for condition of exposure indicated and for long term, maintenance free operation under normal traffic load operation. Coordinate activation control with electrified hardware and access control interfaces. Activation switches are standard SPST, with optional DPDT availability.

J. Signage: As required by cited ANSI/BHMA A 156.19 standard for the type of operator.

K. Acceptable manufacturers: Subject to compliance with requirements:

1. Norton Door Controls (NO) – 6000 Series

2.14 SURFACE MOUNTED CLOSER HOLDERS

A. Electromagnetic door holders: Certified ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate.12vdc, 24vac, 24vdc and 120vac. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.

1. Acceptable manufacturers:

a. Rixson Door Controls (RF) - 980/990 series.
b. Sargent Manufacturing (SA) - 1560 series.

2.15 ARCHITECTURAL TRIM

A. Door protective trim

1. General: Door protective trim units to be of type and design as specified below or in the hardware sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2” less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1” less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the hardware sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.

4. Protection plates: ANSI/BHMA A156.6 certified metal protection plates (kick, armor, or mop), fabricated from the following:

    a. Stainless steel: 300 series, .050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the hardware sets. Provide countersunk screw holes.

6. Acceptable manufacturers:

    a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

2.16 DOOR STOPS AND HOLDERS

A. General: door stops and holders to be of type and design as specified below or in the hardware sets.

B. Door stops and bumpers: ANSI/BHMA A 156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in hardware sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Acceptable manufacturers:

    a. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).

C. Overhead door stops and holders: ANSI/BHMA A 156.6, grade 1 certified overhead stops and holders to be surface or concealed types as indicated in hardware sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Acceptable manufacturers:

    a. Rixson Door Controls (RF).
    b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    c. Sargent Manufacturing (SA).

2.17 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the hardware sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke labeled gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire labeled gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C standard for positive pressure fire tests of door assemblies, and NFPA 252, fire tests of door assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable seal strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Acceptable manufacturers:

1. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.18 ELECTRONIC ACESSORIES

A. Key switches: Key switches furnished standard with stainless steel single gang face plate with a 12/24vdc bi-color led indicator. Integral backing bracket permits integration with any 1 1/4" or 1 1/2" mortise type cylinder. Key switches available as momentary or maintained action and in narrow face plate options.

1. Acceptable manufacturers:

a. Alarm Controls (AK) – MCK Series.
b. Securitron (SU) - MK Series

B. Switching power supplies: Provide power supplies with either single or dual voltage configurations at 12 or 24 VDC. Power supplies shall have battery backup function with an integrated battery charging circuit and shall provide capability for power distribution direct lock control and Fire Alarm Interface (FAI) through add on modules. Power supplies shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs.

1. Acceptable manufacturers:

a. Securitron (SU) - AQD series.
b. Altronix (QX) – Waypoint Series.

2.19 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.20 FINISHES

A. Standard: Designations used in the hardware sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. General contractor to examine scheduled openings, with installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow metal doors and frames: comply with ANSI/DHI A115 series.

B. Wood doors: comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
2. Locks shall be equipped with temporary cores as specified and shall be confirmed to be functional and operational. Temporary keys shall be provided to owner upon completion of installation and verification of functionality.

B. Electrified hardware: All electrified hardware is to be connected and electrically sound by the hardware installer, to include connections to local power supply, transfer hinge, power transfer, or door loop and installation of harness from power transfer to security junction box above door. All connections beyond the security junction box above door or associated local power supply are the responsibility of the security contractor.

C. Mounting heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard steel doors and frames: DHI's "Recommended Locations for Architectural Hardware For Standard Steel Doors And Frames."
2. Wood doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

D. Retrofitting: Install door hardware to comply with manufacturer's published templates and 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 work specified in Division 9 sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 section "Joint Sealants."

F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch-Out Report): Reference Division 01 Section “Closeout Procedures”. Final inspect installed door hardware and state in report whether work complies with or deviates from specification requirements, including whether door hardware is properly installed, operating 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.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner’s maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.

C. Manufacturer's / Vendor's (VEN) Abbreviations:
   1. MK – McKinney
   2. OT – Other
   3. PE – Pemko
   4. RO – Rockwood
   5. SA - Sargent
   6. HS – HES
   7. RF – Rixson
   8. NO – Norton
   9. MR – Markar
   10. SU – Securitron
   11. DX – Detex Corporation
   12. AX – Altronics
   13. KX – Keedex
   14. YA – Yale Commercial
   15. SI - Simplex

3.9 HARDWARE SCHEDULE

A. Set: S-00

1. Doors: AUTOMATIC SLIDING DOOR – UFF, GSF SSD
2. Description: AUTOMATIC SLIDING ALUMINUM | FUNCTION: ELECTRONIC ACCESS CONTROLLED, FAIL SECURE.

1	Hardware	Door Manufacturer	OT	

3. Notes: REFER TO SEPARATE SPECIFICATION SECTION FOR AUTOMATIC ENTRANCES. STANLEY DURAGLIDE 3000 AND BESAM SL500 ARE APPROVED MANUFACTURERS AND MODELS FOR SLIDING DOOR APPLICATIONS.

B. Set: S-01

1. Doors: MAIN EMPLOYEE/RECRUIT OFFICE ENTRY WITH AUTOMATIC OPERATOR
   Description: ALUMINUM STOREFRONT | FUNCTION: ELECTRIC LATCH RETRACTION, FAIL SECURE, INTEGRATED REQUEST TO EXIT

2	Continuous Hinge w/cutout	_FM SLF-HD1 PT	PE
1	CVR Exit Dev (ELR, RX, NL, PULL)	55 56 70 AD8610 106 x 862	SA
1	CVR Exit Dev (ELR, RX, PULL)	55 56 AD8610 862	SA
1	Mortise Cylinder	70 43 (key switch)	SA
2	Permanent Keyed Core	By others	OT
1	Automatic Door Operator	6061	NO
1	Surface Closer (TOP JAMB)	UNIJ7500	NO
1	Threshold & Weatherseal	Door manufacturer	OT
2	Electric Power Transfer	EL-CEPT	SU
2	ElectroLynx Harness	QC-C1500(P)	MK
2	ElectroLynx Harness	QC-C (P) as required	MK
2	Door Position Switch	By security contractor	OT
1	Card Reader	By security contractor	OT
1	Door Operator Switch	502 (verify w/as built architectural conditions)	NO
1	Keyswitch	MKA (automatic operator)	SU
1	Switch Post	500 (includes switch)	NO
1	Power Supply	AQD2 x PDB	SU
1	Wiring & Riser Diagram	By hardware supplier as required	

2. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT
3. MANUFACTURER: VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. LOCAL POWER SUPPLY IS REQUIRED. DOOR HARDWARE INSTALLER SHALL INSTALL POWER SUPPLY IN CONCEALED LOCATION

NEAR BY TO THE DOOR IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS. PROVIDE POWER TO DOOR OPERATOR AND COORDINATE ROUGH-IN REQUIREMENTS WITH E.C. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

C. Set: S-02

1. Doors: MAIN EMPLOYEE ENTRY ELECTRIC LATCH RETRACTION
2. Description: ALUMINUM STOREFRONT | FUNCTION: ELECTRIC LATCH RETRACTION, FAIL SECURE, INTEGRATED REQUEST TO EXIT

2	Continuous Hinge w/cutout	_FM SLF-HD1 PT	PE	
1	1 CVR Exit Dev (ELR, RX, NL,	55 56 70 AD8610 106 x 862	SA	
1	CVR Exit Dev (ELR, RX, PULL)	55 56 AD8610 862	SA	
1	Permanent Keyed Core	By others	OT	
2	Surface Closer (TOP JAMB)	UNIJ7500	NO	
1	Threshold & Weatherseal	Door manufacturer	OT	
2	Electric Power Transfer	EL-CEPT	SU	
2	ElectroLynx Harness	QC-C1500(P)	MK	
2	ElectroLynx Harness	QC-C (P) as required	MK	
2	Door Position Switch	By security contractor	OT	
1	Card Reader	By security contractor	OT	
1	Power Supply	AQD2 x PDB	SU	
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL (CARD READER NOT REQUIRED AT EVERY DOOR; SEE SECURITY DRAWINGS FOR REQUIREMENTS). ALWAYS FREE EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT MANUFACTURER. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. LOCAL POWER SUPPLY IS REQUIRED. DOOR HARDWARE INSTALLER SHALL INSTALL POWER SUPPLY IN CONCEALED LOCATION NEAR BY TO THE DOOR IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

D. Set: S-02A

1. Doors: EMERGENCY EXIT ONLY – PAIR
2. Description: ALUMINUM STOREFRONT | FUNCTION: NO OUTSIDE OPERATION

2	Continuous Hinge	_FM SLF-HD1	PE
2	CVR Exit Device (EO)	AD8610 EO	SA
2	Drop Plate	7788	NO
2	Surface Closer (STOP)	CPS7500	NO
2	Blade Stop Spacer Kit	6190/6191 as required	NO
1	Threshold & Weatherseal	Door manufacturer	OT
1	Sign by Owner	"Emergency Exit Only"	OT
2	Door Position Switch	By security contractor	OT

3. Notes: EXIT ONLY. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. PROVIDE REQUIRED TESTED AND

APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

E. Set: S-02B

1. Doors: EMERGENCY EXIT WITH KEYED ENTRY - PAIR
2. Description: ALUMINUM STOREFRONT | FUNCTION: EXTERIOR PULL, STOREROOM FUNCTION

2	Continuous Hinge	_FM SLF-HD1	PE
1	CVR Exit Device (NL, PULL)	70 AD8610 106 x 862	SA
1	CVR Exit Device (PULL)	AD8610 862	SA
1	Permanent Keyed Core	By others	OT
2	Surface Closer (TOP JAMB)	UNIJ7500	NO
1	Threshold & Weatherseal	Door manufacturer	OT
1	Sign by Owner	"Emergency Exit Only"	OT
2	Door Position Switch	By security contractor	OT

3. Notes: KEYED ENTRY ON ONE LEAF ONLY. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. PROVIDE REQUIRED TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

F. Set: S-02C

1. Doors: MAIN EMPLOYEE ENTRY ELECTRIFIED TRIM
2. Description: ALUMINUM STOREFRONT | FUNCTION: ELECTRIFIED EXIT DEVICE TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT

2	Continuous Hinge w/cutout	_FM SLF-HD1 PT	PE
2	CVR Exit Dev(ELEC LEVER, RX)	55 AD8674-24V ETP	SA
1	Exit Device Trim (NL)	70 106	SA
1	Permanent Keyed Core	By others	OT
2	Surface Closer (TOP JAMB)	UNIJ7500	NO
2	Electric Power Transfer	EL-CEPT	SU
2	ElectroLynx Harness	QC-C1500(P)	MK
2	ElectroLynx Harness	QC-C (P) as required	MK
2	Door Position Switch	By security contractor	OT
1	Card Reader	By security contractor	OT
1	Power Supply	By security contractor	OT
1	Wiring & Riser Diagram	By hardware supplier as required	

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL (CARD READER NOT REQUIRED AT EVERY DOOR; SEE SECURITY DRAWINGS FOR REQUIREMENTS). ALWAYS FREE EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT MANUFACTURER. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. LOCAL POWER SUPPLY IS NOT REQUIRED. SECURITY CONTRACTOR SHALL PROVIDE LOCK POWER AND MAKE FINAL CONNECTIONS AT THE CONCEALED POWER TRANSFER. PROVIDE TESTED

AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

G. Set: S-02D

1. Doors: MAIN EMPLOYEE ENTRY MECHANICAL WITH AUTOMATIC OPERATOR Description: ALUMINUM STOREFRONT | FUNCTION: EXTERIOR PULL, STOREROOM FUNCTION WITH ELECTRIC LATCH RETRACTION

1	Continuous Hinge w/cutout	_FM SLF-HD1 PT	PE	
1	Continuous Hinge	_FM SLF-HD1	PE	
1	CVR Exit Dev (ELR, NL, PULL)	56 70 AD8610 106 x 862	SA	
1	CVR Exit Dev (PULL)	AD8610 862	SA	
1	Mortise Cylinder	70 43 (key switch)	SA	
2	Permanent Keyed Core	By others	OT	
1	Automatic Door Operator	6061	NO	
1	Surface Closer (TOP JAMB)	UNIJ7500	NO	
1	Threshold & Weatherseal	Door manufacturer	OT	
1	Electric Power Transfer	EL-CEPT	SU	
1	ElectroLynx Harness	QC-C1500(P)	MK	
1	ElectroLynx Harness	QC-C (P) as required	MK	
2	Door Position Switch	By security contractor	OT	
1	Door Operator Switch	502 (verify w/as built architectural conditions)	NO	
1	Keyswitch	MKA (automatic operator)	SU	
1	Switch Post	500 (includes switch)	NO	
1	Power Supply	AQD2 x PDB	SU	
1	Wiring & Riser Diagram	By hardware supplier as required.		

2. Notes: STOREROOM FUNCTION EXIT DEVICE. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT MANUFACTURER. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. LOCAL POWER SUPPLY IS REQUIRED. DOOR HARDWARE INSTALLER SHALL INSTALL POWER SUPPLY IN CONCEALED LOCATION NEAR BY TO THE DOOR IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS. PROVIDE POWER TO DOOR OPERATOR AND COORDINATE ROUGH-IN REQUIREMENTS WITH E.C. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

H. Set: S-02E

1. Doors: MAIN ASSOCIATE ENTRY - PAIR WITH MULLION AND AUTOMATIC OPERATOR
2. Description: ALUMINUM STOREFRONT | FUNCTION: ELECTRIC LATCH RETRACTION X ELECTRIFIED EXIT DEVICE TRIM

2	Continuous Hinge w/cutout	_FM SLF-HD1 PT	PE	
1	Removable Lockable Mullion	L980S	SA	
1	Rim Exit Dev (ELR, RX, CLSRM)	55 56 70 8813 ETP	SA	
1	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876-24V ETP	SA	

1	Mortise Cylinder	70 43 (key switch)	SA	
1	Mullion Cylinder Kit	70 980C1	SA	
4	Permanent Keyed Core	By others	OT	
1	Automatic Door Operator	6061	NO	⚡
1	Surface Closer (TOP JAMB)	UNIJ7500	NO	
1	Threshold & Weatherseal	Door manufacturer	OT	
1	Mullion Seal	5110BL	PE	
2	Electric Power Transfer	EL-CEPT	SU	⚡
2	ElectroLynx Harness	QC-C1500(P)	MK	⚡
2	ElectroLynx Harness	QC-C (P) as required	MK	⚡
2	Door Position Switch	By security contractor	OT	
1	Card Reader	By security contractor	OT	
1	Door Operator Switch	502 (verify w/as built architectural conditions)	NO	⚡
1	Keyswitch	MKA (automatic operator)	SU	⚡
1	Switch Post	500 (includes switch)	NO	⚡
1	Power Supply	AQD2 x PDB	SU	⚡
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT MANUFACTURER. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. LOCAL POWER SUPPLY IS REQUIRED. DOOR HARDWARE INSTALLER SHALL INSTALL POWER SUPPLY IN CONCEALED LOCATION NEAR BY TO THE DOOR IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS. PROVIDE POWER TO DOOR OPERATOR AND COORDINATE ROUGH-IN REQUIREMENTS WITH E.C. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

I. Set: S-02F

1. Doors: MAIN ASSOCIATE ENTRY PAIR WITH MULLION
2. Description: HOLLOW METAL DOOR | FUNCTION: RIM EXIT DEVICE WITH ELECTRIFIED TRIM

4	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK	
2	Electric Hinge, Hvy Wt	T4A3386-QC8	US32D	MK	⚡
1	Removable Lockable Mullion	L980S	PC	SA	
2	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876-24V ETP	US32D	SA	⚡
1	Mullion Cylinder Kit	70 980C1	US26D	SA	
3	Permanent Keyed Core	By others	626	OT	
2	Surface Closer (STOP)	CPS7500	689	NO	
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2" LDW CSK	US32D	RO	
1	Threshold	273x3AFG		PE	
1	Mullion Seal	5110BL		PE	
1	Gasketing (HEAD)	2893AV		PE	

2	Gasketing (JAMBS)	2903AV	PE
2	Door Bottom	216BDCFG	PE
2	Meeting Stile Seal	303AV	PE
2	ElectroLynx Harness	QC-C1500(P)	MK
2	ElectroLynx Harness	QC-C (P) as required	MK
1	Card Reader	By security contractor	OT
1	Power Supply	By security contractor	OT
2	Door Position Switch	By security contractor	OT
1	Wiring & Riser Diagram	By hardware supplier as Required	

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

J. Set: S-03

1. Doors: EMERGENCY EXIT ONLY - SINGLE ALUMINUM
2. Description: ALUMINUM STOREFRONT | FUNCTION: NO EXTERIOR TRIM OR OUTSIDE OPERATION

1	Continuous Hinge	_FM SLF-HD1	PE
1	Rim Exit Device (EO)	8810 EO	SA
1	Surface Closer	UNI7500	NO
1	Drop Plate	7788	NO
1	Blade Stop Spacer Kit	6190/6191 as required	NO
1	Threshold & Weatherseal	Door manufacturer	OT
1	Door Position Switch	By security contractor	OT
1	Sign by Owner	"Emergency Exit Only"	OT

3. Notes: EXIT ONLY. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. PROVIDE REQUIRED TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

K. Set: S-03A

1. Doors: EMERGENCY EXIT WITH KEYED ENTRY – SINGLE
2. Description: ALUMINUM STOREFRONT | FUNCTION: EXTERIOR PULL, STOREROOM FUNCTION

1	Continuous Hinge	_FM SLF-HD1	PE
1	Rim Exit Device, (STORE, PULL)	70 8804 862	SA
1	Permanent Keyed Core	By others	OT
1	Surface Closer	UNI7500	NO
1	Drop Plate	7788	NO
1	Blade Stop Spacer Kit	6190/6191 as required	NO
1	Threshold & Weatherseal	Door manufacturer	OT
1	Door Position Switch	By security contractor	OT

1	Sign by Owner	"Emergency Exit Only"	OT

3. Notes: KEYED ENTRY FROM EXTERIOR. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

L. Set: S-03B

1. Doors: TRUCKERS' LOUNGE/SMOKERS' CANOPY - SINGLE
2. Description: ALUMINUM STOREFRONT | FUNCTION: EXTERIOR LEVER, CLASSROOM FUNCTION

1	Continuous Hinge	_FM SLF-HD1	PE
1	Rim Exit Device (CLSRM, LEVER)	70 8813 ETP	SA
1	Permanent Keyed Core	By others	OT
1	Surface Closer	UNI7500	NO
1	Drop Plate	7788	NO
1	Blade Stop Spacer Kit	6190/6191 as required	NO
1	Threshold & Weatherseal	Door manufacturer	OT
1	Door Position Switch	By security contractor	OT

3. Notes: CLASSROOM FUNCTION EXIT DEVICE. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. HW SET 3B SHALL ALSO BE PROVIDED FOR SMOKERS CANOPY ENTRANCE DOORS THAT WILL NOT REQUIRE ELECTRONIC ACCESS CONTROLS. CONFIRM REQUIREMENTS WITH SECURITY DESIGNER. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

M. Set-03C

1. Doors: MAIN ASSOCIATE ENTRY
2. Description: SINGLE ALUMINUM STOREFRONT | FUNCTION: EXTERIOR PULL, STOREROOM FUNCTION

1	Continuous Hinge	_FM SLF-HD1	PE
1	Rim Exit Device (STORE, PULL)	70 8804 862	SA
1	Permanent Keyed Core	By others	OT
1	Surface Closer	UNI7500	NO
1	Drop Plate	7788	NO
1	Blade Stop Spacer Kit	6190/6191 as required	NO
1	Threshold & Weatherseal	Door manufacturer	OT
1	Door Position Switch	By security contractor	OT

3. Notes: STOREROOM FUNCTION EXIT DEVICE. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. HW SET 3C SHALL ALSO BE PROVIDED FOR MAIN ASSOCIATE ENTRANCE DOORS THAT WILL NOT REQUIRE ELECTRONIC ACCESS CONTROLS. CONFIRM REQUIREMENTS WITH SECURITY DESIGNER. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

N. Set: S-04

1. Doors: EMERGENCY EXIT ONLY - SINGLE HM
2. Description: SHELL EXTERIOR EGRESS DOOR | FUNCTION: NO EXTERIOR TRIM OR OUTSIDE OPERATION

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Rim Exit Device (EO)	8810 EO	US32D	SA
1	Surface Closer (STOP)	CPS7500	689	NO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Door Position Switch	By security contractor		OT

3. Notes: EXIT DEVICE DOES NOT INCLUDE EXTERIOR TRIM. CONFIRM IF COMPLIANT WITH LOCAL CODE; OTHERWISE EQUIP WITH HW SET 4D. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

O. Set: S-04A

1. Doors: NON-FULFILLMENT BUSINESS UNIT
2. Description: EMERGENCY EXIT, STAND ALONE BATTERY ALARM | FUNCTION: EXTERIOR PULL, STOREROOM FUNCTION

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Rim Exit Dev (ALARM, STORE,	AL 70 8804 PSB	US32D	SA
2	Permanent Keyed Core	By others	626	OT
1	Surface Closer (STOP)	CPS7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H x 2” LDW CSK	US32D	RO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Door Position Switch	By security contractor		OT

3. Notes: PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

P. Set: S-04B

1. Doors: EXTERIOR TRUCKERS' LOUNGE, TRUCKERS' CAGE, SMOKING
2. Description: ACCESSIBLE SHELL EXTERIOR DOOR | FUNCTION: EXTERIOR LEVER, CLASSROOM FUNCTION

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Rim Exit Device (CLSRM, LEVER)	70 8813 ETP	US32D	SA
1	Permanent Keyed Core	By Others	626	OT

1	Surface Closer (STOP)	CPS7500	689	NO
1	Armor Plate (PUSH)	K1050 (-F) 34" H x 2” LDW CSK	US32D	RO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Door Position Switch	By security contractor		OT

3. Notes: PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

Q. Set: S-04C

1. Doors: SET NOT USED

1	Hardware Set	Currently not used	OT

R. Set: S-04D

1. Doors: EMERGENCY EXIT INCLUDING EXTERIOR TRIM
2. Description: SHELL EXTERIOR DOOR | FUNCTION: EXTERIOR PULL, STOREROOM FUNCTION

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Rim Exit Device (STORE, PULL)	70 8804 PSB	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (STOP)	CPS7500	689	NO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Door Position Switch	By security contractor		OT

3. Notes: PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

S. Set: S-04E

1. Doors: EMERGENCY EXIT ONLY - PAIR HM
2. Description: SHELL EXTERIOR EGRESS DOOR | FUNCTION: NO EXTERIOR TRIM OR OUTSIDE OPERATION

6	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Removable Lockable Mullion	L980S	PC	SA
2	Rim Exit Device (EO)	8810 EO	US32D	SA
1	Mullion Cylinder Kit	70 980C1	US26D	SA
1	Permanent Keyed Core	By others	626	OT
2	Surface Closer (STOP)	CPS7500	689	NO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE

1	Gasketing (HEAD)	2893AV	PE
2	Gasketing (JAMBS)	2903AV	PE
2	Door Bottom	216BDCFG	PE
2	Meeting Stile Seal	303AV	PE
1	Mullion Seal	5110BL	PE
2	Door Position Switch	By security contractor	OT

3. Notes: EXIT DEVICE DOES NOT INCLUDE EXTERIOR TRIM. CONFIRM IF COMPLIANT WITH LOCAL CODE; OTHERWISE EQUIP WITH HW SET 4F. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

T. Set: S-04F

1. Doors: EMERGENCY EXIT INCLUDING EXTERIOR TRIM - PAIR
2. Description: SHELL EXTERIOR DOOR | FUNCTION: EXTERIOR PULL, STOREROOM FUNCTION

6	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Removable Lockable Mullion	L980S	PC	SA
2	Rim Exit Device (STORE, PULL)	70 8804 PSB	US32D	SA
1	Mullion Cylinder Kit	70 980C1	US26D	SA
3	Permanent Keyed Core	By others	626	OT
2	Surface Closer (STOP)	CPS7500	689	NO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
2	Door Bottom	216BDCFG		PE
2	Meeting Stile Seal	303AV		PE
1	Mullion Seal	5110BL		OT
2	Door Position Switch	By security contractor		OT

3. Notes: PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

U. Set: S-05

1. Doors: TDR, TOM, SMOKERS' CANOPY (ACCESS CONTROLLED)
2. Description: SHELL EXTERIOR DOOR | FUNCTION: ELECTRIFIED EXIT DEVICE TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876- 24V ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (STOP)	CPS7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H x 2" LDW CSK	US32D	RO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE

1	Gasketing (HEAD)	2893AV	PE
2	Gasketing (JAMBS)	2903AV	PE
1	Door Bottom	216BDCFG	PE
1	Door Position Switch	By security contractor	OT
2	Card Reader	By security contractor	OT
1	Surface Armored Door Cord	KEEDEX K-DL38A	KX
1	Power Supply	By security contractor	OT
1	Wiring & Riser Diagram	By hardware supplier as required	

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. CARD IN / CARD OUT TO SHUNT EGRESS ALARM BY SECURITY CONTRACTOR. LOCK POWER SHALL BE PROVIDED BY THE SECURITY CONTRACTOR. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

V. Set: S-05A

1. Doors: MAIN ASSOCIATE, RECRUITMENT, SMOKERS' CANOPY ENTRY (WITHOUT AUTOMATIC OPERATOR)
2. Description: ALUMINUM STOREFRONT ACCESS CONTROLLED ENTRANCE | FUNCTION: ELECTRIFIED EXIT DEVICE TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT.

1	Continuous Hinge w/cutout	_FM SLF-HD1 PT		PE
1	Rim Exit Dev (ELEC LVR, RX)	55 70 8876-24V ETP		SA
1	Permanent Keyed Core	By others		OT
1	Surface Closer (STOP)	CPS7500	689	NO
1	Drop Plate	7788	689	NO
1	Threshold & Weatherseal	Door manufacturer		OT
1	Electric Power Transfer	EL-CEPT		SU
1	ElectroLynx Harness	QC-C1500(P)		MK
1	ElectroLynx Harness	QC-C (P) as Required		MK
1	Door Position Switch	By security contractor		OT
1	Card Reader (QTY VARIES)	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier As required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT MANUFACTURER. LOCK POWER SHALL BE PROVIDED BY THE SECURITY CONTRACTOR. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. PROVIDE TESTED AND APPROVED HARDWARE

FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES. CARD READER QUANTITIES VARY; CONFIRM EXPECTATIONS WITH SECURITY DESIGNER.

W. Set: S-05B

1. Doors: BUILDING ENTRY WITH AUTOMATIC OPERATOR – SINGLE
2. Description: HOLLOW METAL ACCESS CONTROLLED ENTRANCE | FUNCTION: ELECTRIC LATCH RETRACTION, FAIL SECURE, INTEGRATED REQUEST TO EXIT

1	Continuous Hinge w/cutout	CFM SLF-HD1 PT		PE	
1	Rim Exit Dev (ELR, RX, NL, PULL)	55 56 70 8804 PSB	US32D	SA	⚡
1	Mortise Cylinder	70 43 (key switch)	US32D	SA	
2	Permanent Keyed Core	By others	626	OT	
1	Automatic Door Operator	6061	689	NO	⚡
1	Threshold	273x3AFG		PE	
1	Rain Guard	346C		PE	
1	Gasketing (HEAD)	2893AV		PE	
2	Gasketing (JAMBS)	2903AV		PE	
1	Door Bottom	216BDCFG		PE	
1	Electric Power Transfer	EL-CEPT		SU	⚡
1	ElectroLynx Harness	QC-C1500(P)		MK	⚡
1	ElectroLynx Harness	QC-C (P) as required		MK	⚡
1	Door Position Switch	By security contractor		OT	
1	Card Reader	By security contractor		OT	
1	Door Operator Switch	502 (verify w/as built architectural conditions)		NO	⚡
1	Keyswitch	MKA (automatic operator		SU	⚡
1	Switch Post	500 (includes switch)		NO	⚡
1	Power Supply	AQD1 x PDB		SU	⚡

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. CARD READERS AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. LOCAL POWER SUPPLY IS REQUIRED. DOOR HARDWARE INSTALLER SHALL INSTALL POWER SUPPLY IN CONCEALED LOCATION NEAR BY TO THE DOOR IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS. CONFIRM SWITCH POST REQUIREMENT. PROVIDE POWER TO DOOR OPERATOR AND COORDINATE ROUGH-IN REQUIREMENTS WITH E.C. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

X. Set: S-05C

1. Doors: BUILDING ENTRY WITH AUTOMATIC OPERATOR, MAIN ASSOCIATE, RECRUITMENT, SMOKERS' CANOPY ENTRY - SINGLE
2. Description: ALUMINUM STOREFRONT ACCESS CONTROLLED ENTRY | FUNCTION: ELECTRIC LATCH RETRACTION, FAIL SECURE, INTEGRATED REQUEST TO EXIT

1	Continuous Hinge w/cutout	_FM SLF-HD1 PT		PE

1	Rim Exit Dev (ELR, RX, NL, PULL)	55 56 70 AD8504 862	SA
1	Mortise Cylinder	70 43 (key switch)	SA
2	Permanent Keyed Core	By others	OT
1	Automatic Door Operator	6061	NO
1	Threshold & Weatherseal	Door manufacturer	OT
1	Electric Power Transfer	EL-CEPT	SU
1	ElectroLynx Harness	QC-C1500(P)	MK
1	ElectroLynx Harness	QC-C (P) as required	MK
1	Door Position Switch	By security contractor	OT
1	Card Reader	By security contractor	OT
1	Door Operator Switch	502 (verify w/as built architectural conditions)	NO
1	Keyswitch	MKA (automatic operator)	SU
1	Switch Post	500 (includes switch)	NO
1	Power Supply	AQD1 x PDB	SU
1	Wiring & Riser Diagram	By hardware supplier as required	

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. CARD READERS AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT MANUFACTURER. VERIFY FINISH ON HARDWARE ABOVE TO MATCH ALUMINUM DOOR AND FRAME FINISH. LOCAL POWER SUPPLY IS REQUIRED. DOOR HARDWARE INSTALLER SHALL INSTALL POWER SUPPLY IN CONCEALED LOCATION NEAR BY TO THE DOOR IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS. CONFIRM SWITCH POST REQUIREMENT. PROVIDE POWER TO DOOR OPERATOR AND COORDINATE ROUGH-IN REQUIREMENTS WITH E.C. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

Y. Set: S-05D

1. Doors: DSP
2. Description: SHELL EXTERIOR DOOR | FUNCTION: ELECTRIFIED EXIT DEVICE TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876-24V ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (STOP)	CPS7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H x 2” LDW CSK	US32D	RO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Door Position Switch	By security contractor		OT
1	Card Reader	By security contractor		OT

1	Surface Armored Door Cord	KEEDEX K-DL38A	KX
1	ElectroLynx Harness	QC-C1500(P)	MK
1	Power Supply	By security contractor	OT
1	Wiring & Riser Diagram	By hardware supplier as required	

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. LOCK POWER SHALL BE PROVIDED BY THE SECURITY CONTRACTOR. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

Z. Set: S-06

1. Doors: EXISTING SHELL DOOR
2. Description: EXISTING SHELL DOORS WITH NO NEW HARDWARE REQUIREMENTS

1	Hardware	Existing	OT

3. Notes: ALL HARDWARE SHOULD BE COMPATIBLE TO ACCCEPT 7-PIN SFIC CORES. ALL EXISTING HARDWARE SHALL CONFORM TO THE BASIC SECURITY DESIGN AS REQUIRED BY Tenant ON A CASE BY CASE BASIS. IF EITHER OF THESE CONDITIONS ARE NOT MET, NEW MATERIAL SHOULD BE SCHEDULED. REFER TO SECTION 1.4 OF THIS DOCUMENT FOR FURTHER INFORMATION AND SURVEY REQUIREMENTS.

AA. Set: S-07

1. Doors: FIRE PUMP ROOM - PAIR
2. Description: SHELL EXTERIOR DOOR | FUNCTION: EXTERIOR LEVER, STOREROOM FUNCTION

6	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
2	Manual Flush Bolt	555	US26D	RO
1	Dust Proof Strike	570	US26D	RO
1	Storeroom Lock	70 8204 LNP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (STOP)	CPS7500	689	NO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (head)	2893AV		PE
2	Gasketing (jambs)	2903AV		PE
2	Door Bottom	216BDCFG		PE
1	Latch Protector	320/321	US32D	RO

3. Notes: METAL ASTRAGAL BY DOOR SUPPLIER. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

BB. Set: S: 07A

1. Doors: EMER EXIT ONLY SUPERVISED, FIRE PUMP ROOM
2. Description: SHELL EXTERIOR DOOR | FUNCTION: EXTERIOR PULL, STOREROOM FUNCTION

6	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Removable Lockable Mullion	L980S	PC	SA
1	Rim Exit Device (EO)	8810 EO	US32D	SA
1	Rim Exit Device (STORE, PULL)	70 8804 PSB	US32D	SA
1	Mullion Cylinder Kit	70 980C1	US26D	SA
2	Permanent Keyed Core	By others	626	OT
2	Surface Closer (STOP)	CPS7500	689	NO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Mullion Seal	5110BL		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
2	Door Bottom	216BDCFG		PE
2	Meeting Stile Seal	303AV		PE

3. Notes: PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

CC. Set: S-07B

1. Doors: FIRE PUMP ROOM - SINGLE
2. Description: SHELL EXTERIOR DOOR | FUNCTION: EXTERIOR LEVER, STOREROOM FUNCTION

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Storeroom Lock	70 8204 LNP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (STOP)	CPS7500	689	NO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (head)	2893AV		PE
2	Gasketing (jambs)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Latch Protector	320/321	US32D	RO

3. Notes: PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES

DD. Set: S-08

1. Doors: SET NOT USED

1	Hardware Set	Currently not used	OT

EE. Set:S-09

1. Doors: GUARDHOUSE DOOR ACCESS CONTROLLED - HOLLOW METAL
2. Description: SHELL EXTERIOR DOOR | FUNCTION: ELECTRIFIED LEVER MORTISE LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Elec Mortise Lock (FAIL SECURE)	RX 70 8271-24V LNP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2" LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	Surface Armored Door Cord	KEEDEX K-DL38A		KX
1	ElectroLynx Harness	QC-C1500(P)		MK
1	Power Supply	By security contractor		OT
1	Latch Protector	320/321	US32D	RO
1	Wiring and Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER, POWER SUPPLY, AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

FF. Set:S-09A

1. Doors: PREFAB GUARD HOUSE
2. Description: EXTERIOR DOOR | FUNCTION: ELECTRIFIED LEVER MORTISE LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT

1	Hardware	Prefab guard house manufacturer	OT
1	Door Position Switch	By security contractor	OT
2	Card Reader	By security contractor	OT
1	Power Supply	By security contractor	OT

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READERS, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR. GENERAL CONTRACTOR TO COORDINATE NEW HARDWARE INSTALLATION REQUIREMENTS WITH SUB-TRADES AND GUARDHOUSE MANUFACTURER. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE

COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

GG. Set: S-09B

1. Doors: GUARD HOUSE RESTROOM
2. Description: EXTERIOR DOOR | FUNCTION: SERVICE STATION FUNCTION, EXTERIOR LEVER

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Service Station Lock	28 70 10G44 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Coat Hook	790	US26D	RO
1	Sign	BF689 Unisex/BF RO Wm’s/BF687 Mn's Blue		

3. Notes: PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

HH. Set: S-09C

1. Doors: TRASH REMOVAL DOOR - HOLLOW METAL >36”
2. Description: SHELL EXTERIOR DOOR | FUNCTION: ELECTRIFIED LEVER MORTISE LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT

4	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Elec Mortise Lock (FAIL SECURE)	RX 70 8271-24V LNP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (STOP)	CPS7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 34" H X 2” LDW CSK	US32D	RO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	ElectroLynx Harness	QC-C1500(P)		MK

1	ElectroLynx Harness	QC-C (P) as required		MK
1	Electric Power Transfer	EL-CEPT		SU
1	Power Supply	By security contractor		OT
1	Latch Protector	320/321	US32D	RO
1	Wiring & Riser Diagram	By hardware supplier as		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER, POWER SUPPLY, AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES. CARD READER EGRESS WILL SHUNT BUILDING ALARM AS AN ACCESS CONTROLLED REQUEST TO EXIT SWITCH.

II. Set: S-10

1. Doors: ROOF TOP ACCESS DOOR
2. Description: EXTERIOR DOOR AT TOP OF ROOF ACCESS STAIR | FUNCTION: MECHANICAL CYLINDER LOCK, STOREROOM FUNCTION

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Storeroom Lock	28 70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2" LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Threshold	273x3AFG		PE
1	Rain Guard	346C		PE
1	Gasketing (HEAD)	2893AV		PE
2	Gasketing (JAMBS)	2903AV		PE
1	Door Bottom	216BDCFG		PE
1	Door Position Switch	By security contractor		OT
1	Latch Protector	320/321	US32D	RO

3. Notes: ACCESS BY KEY FROM INSIDE ROOM OR STAIR. ALWAYS FREE EGRESS FROM ROOF. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

JJ. Set: S-10A

1. 1. Doors: ROOF TOP ACCESS DOOR (ALTERNATE DOUBLE CYLINDER)
2. Description: EXTERIOR DOOR | FUNCTION: MECHANICAL CYLINDER LOCK, STOREROOM FUNCTION

3	Hinge, Hvy Wt	T4A3386 NRP	US32D	MK
1	Store Door Lock	70 8226 LNP	US32D	SA
2	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO

1	Threshold	273x3AFG	PE
1	Rain Guard	346C	PE
1	Gasketing (HEAD)	2893AV	PE
2	Gasketing (JAMBS)	2903AV	PE
1	Door Bottom	216BDCFG	PE
1	Door Position Switch	By security contractor	OT

3. Notes: KEYED BOTH SIDES. PROVIDE ONLY IF ACCEPTABLE TO LAHJ AND REQUIRED BY ROOF AND BUILDING CONFIGURATION. PROVIDE TESTED AND APPROVED HARDWARE FOR HURRICANE AND WINDSTORM CODE COMPLIANT OPENINGS WHERE PROJECT IS SUBJECT TO THOSE CONSTRUCTION CODES.

KK. Set: TI-01

1. Doors: SINGLE LEAF, TURNSTILE BYPASS, ASSOC ENTRY
2. Description: INTERIOR EGRESS DOOR | FUNCTION: ELECTRIFIED EXIT DEVICE LEVER TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT

2	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Electric Hinge, Hvy Wt	T4A3786-QC8	US26D	MK
1	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876-24V ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2" LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1" LDW CSK	US32D	RO
3	Silencer	608-RKW		RO
1	ElectroLynx Harness	QC-C300(P)		MK
1	Door Position Switch	By security contractor		OT
1	Card Reader (QTY VARIES)	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring and Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. POWER SUPPLY, CARD READERS AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. CARD READER ON EGRESS SIDE WILL SHUNT BLDG ALARM AS AN ACCESS CONTROLLED REQUEST TO EXIT SIGNAL. LOCK POWER SHALL BE PROVIDED BY THE SECURITY CONTRACTOR. COORDINATE CARD READER QUANTITIES WITH SECURITY DRAWINGS.

LL. Set: TI-01A

1. Doors: SINGLE LEAF, TURNSTILE BYPASS EMERGENCY EXIT ONLY
2. Description: INTERIOR EGRESS DOOR | FUNCTION: NO EXTERIOR TRIM OR OUTSIDE OPERATION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Exit Device (EO)	8810 EO	US32D	SA

1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2" LDW CSK	US32D	RO
3	Silencer	608-RKW		RO

3. Notes: EXIT ONLY.

NN. Set: TI-01C

1. Doors: RECRUITMENT OFFICE VESTIBULE
2. Description: ALUMINUM | FUNCTION: ELECTRIFIED EXIT DEVICE LEVER TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT

1	Continuous Hinge w/cutout	CFM_SLF-HD1 PT		PE
1	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876-24V ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	UNI7500	689	NO
1	Drop Plate	7788	689	NO
1	Blade Stop Spacer Kit	6190/6191 as required	689	NO
1	Electric Power Transfer	EL-CEPT		SU
1	ElectroLynx Harness	QC-C1500(P)		MK
1	ElectroLynx Harness	QC-C (P) as required		MK
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER, POWER SUPPLY, AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT MANUFACTURER. CARD IN / CARD OUT TO SHUNT EGRESS ALARM BY SECURITY CONTRACTOR. LOCK POWER SHALL BE PROVIDED BY THE SECURITY CONTRACTOR. INSTALLER SHALL PROVIDE REX CONNECTION FROM TRIM TO HINGE.

OO. Set: TI-01C(ALT)

1. Doors: RECRUITMENT OFFICE TURNSTILE, VISITOR BYPASS WITH AUTOMATIC OPERATOR
2. Description: ALUMINUM | FUNCTION: ELECTRIFIED EXIT DEVICE LEVER TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT

1	Continuous Hinge w/cutout	CFM SLF-HD1 PT		PE
1	Rim Exit Dev (ELR, ELEC, RX)	55 56 70 8804 ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Mortise Cylinder	70 43 (key switch)	US32D	SA
1	Automatic Door Operator	6061	689	NO

2	Door Operator Switch	502 (verify w/as building architectural conditions)	NO
1	Keyswitch	MKA (automatic operator)	SU
1	Electric Power Transfer	EL-CEPT	SU
1	ElectroLynx Harness	QC-C300(P)	MK
1	Door Position Switch	By security contractor	OT
2	Card Reader	By security contractor	OT
1	Power Supply	AQD1 x PDB	SU
1	Wiring and Riser Diagram	By hardware supplier as required	

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER, POWER SUPPLY, AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. EPT PREP TO BE COORDINATED BY ALUMINUM STOREFRONT MANUFACTURER. CARD IN / CARD OUT TO SHUNT EGRESS ALARM BY SECURITY CONTRACTOR. LOCK POWER SHALL BE PROVIDED BY THE SECURITY CONTRACTOR. LOCAL POWER SUPPLY IS REQUIRED. DOOR HARDWARE INSTALLER SHALL INSTALL POWER SUPPLY IN CONCEALED LOCATION NEAR BY TO THE DOOR IN ACCORDANCE WITH MANUFACTURER SPECIFICATIONS. PROVIDE POWER TO DOOR OPERATOR AND COORDINATE ROUGH-IN REQUIREMENTS WITH E.C. INSTALL SHALL PROVIDE REX CONNECTION FROM TRIM TO HINGE.

PP. Set: TI-01D

1. Doors: DOUBLE LEAF, TURNSTILE BYPASS, ASSOC ENTRY
2. Description: INTERIOR EGRESS DOOR | FUNCTION: ELECTRIFIED EXIT DEVICE LEVER TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT

4	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
2	Electric Hinge, Hvy Wt	T4A3786-QC8	US26D	MK
1	Removable Lockable Mullion	L980S	PC	SA
2	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876-24V ETP	US32D	SA
1	Mullion Cylinder Kit	70 980C1	US26D	SA
3	Permanent Keyed Core	By others	626	OT
2	Surface Closer	(P)7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
2	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
2	Door Position Switch	By security contractor		OT
1	Card Reader (QTY VARIES)	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. POWER SUPPLY, CARD READERS AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. CARD READER ON EGRESS SIDE WILL SHUNT BLDG

ALARM AS AN ACCESS CONTROLLED REQUEST TO EXIT SIGNAL. LOCK POWER SHALL BE PROVIDED BY THE SECURITY CONTRACTOR. COORDINATE CARD READER QUANTITIES WITH SECURITY DRAWINGS.

QQ. Set: TI-01E

1. Doors: DOUBLE LEAF, TURNSTILE BYPASS EMERGENCY EXIT ONLY
2. Description: INTERIOR EGRESS DOOR | FUNCTION: NO EXTERIOR TRIM OR OUTSIDE OPERATION

6	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Removable Lockable Mullion	L980S	PC	SA
2	Rim Exit Device (EO)	8810 EO	US32D	SA
1	Mullion Cylinder Kit	70 980C1	US26D	SA
1	Permanent Keyed Core	By others	626	OT
2	Surface Closer	(P)7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
2	Silencer	608-RKW		RO
1	Mullion Seal	5110BL		PE

3. Notes: EXIT ONLY.

RR. Set: TI-02

1. Doors: CARD IN/CARD OUT (LOCKED IN BOTH DIRECTIONS), SPECIAL USE CASE DUAL DIRECTION ACCESS CONTROL HARDWARE SET (NO FREE EGRESS)
2. Description: INTERIOR WOOD DOOR | FUNCTION: ELECTRIFIED LEVER MORTISE LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT, LOCKED BOTH DIRECTIONS

2	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Electric Hinge, Hvy Wt	T4A3786-QC8	US26D	MK
1	Elec Mortise Lock (FAIL SAFE)	RX 70 8272-12V LNP	US26D	SA
2	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE
1	ElectroLynx Harness	QC-C300(P)		MK
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	Emergency Door Release	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier as Required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL CARD REQUIRED THROUGH BOTH DIRECTIONS OF TRAVEL. CARD READERS, EMERGENCY DOOR RELEASE BUTTON, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR. THIS OPENING IS NOT EGRESS COMPLIANT.

SS. Set: TI-02A

1. Doors: EGRESS CORRIDOR ENTRY
2. Description: INTERIOR EGRESS DOOR | FUNCTION: EXTERIOR LEVER, STOREROOM FUNCTION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Exit Device (STORE, LEVER)	70 8804 ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE
1	Sweep	315CN		PE
1	Door Position Switch	By security contractor		OT
1	Sign by Owner	"Emergency Exit Only - Alarm Will Sound”		OT

3. Notes: DOOR SHALL BE CONFIGURED AS EMERGENCY EXIT ONLY. DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR.

TT. Set: TI-02B

1. Doors: DAY ONE TRAINING, TRUCKERS' LOUNGE, DRIVER CHECK IN, HUB STAGING ACCESS FROM WAREHOUSE (HM DOOR)
2. Description: ACCESS CONTROLLED INTERIOR EGRESS DOOR | FUNCTION: ELECTRIFIED EXIT DEVICE LEVER TRIM, FAIL SECURE, INTEGRATED REQUEST TO EXIT

2	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Electric Hinge, Hvy Wt	T4A3786-QC8	US26D	MK
1	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876-24V ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
3	Silencer	608-RKW		RO
1	ElectroLynx Harness	QC-C300(P)		MK
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier as		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE

EGRESS. CARD READER AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. CARD READER EGRESS WILL SHUNT BUILDING ALARM AS AN ACCESS CONTROLLED REQUEST TO EXIT SWITCH.

UU. Set: TI-04

1. Doors: TRAINING, CAREER CHOICE CLASSROOM
2. Description: INTERIOR DOOR | FUNCTION: EXTERIOR LEVER, PASSAGE FUNCTION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Fire Exit HW (PASSAGE)	12 8815 ETP	US32D	SA
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDWCSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE

VV. Set: TI-04A

1. Doors: ACADEMY ROOM, FIRST DAY TRAINING ROOM (ACCESS CONTROLS NOT REQUIRED)
2. Description: INTERIOR DOOR | FUNCTION: EXTERIOR LEVER, CLASSROOM FUNCTION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Fire Exit HW (CLASSROOM)	12 70 8813 ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDWCSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE

XX. Set: TI-04B

1. Doors: ACADEMY ROOM, FIRST DAY TRAINING ROOM (ACCESS CONTROLS NOT REQUIRED) - PAIR
2. Description: INTERIOR DOOR | FUNCTION: EXTERIOR LEVER, CLASSROOM FUNCTION

6	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
2	SVR Fire Exit HW	12 70 NB8713 ETP	US32D	SA
2	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Surface Closer (STOP)	CPS7500	689	NO
2	Armor Plate	K1050 (-F) 34" CSK BEV	US32D	RO
1	Dome Floor Stop	441	US26D	RO
1	Gasketing	S88D		PE
2	Meeting Stile Seal	305CN		PE

YY. Set: TI-05

1. Doors: ACADEMY ROOM/WAREHOUSE/RECRUIT OFFICE EMERGENCY EXIT
2. Description: INTERIOR EGRESS DOOR | FUNCTION: NO EXTERIOR

TRIM, EMERGENCY EXIT ONLY

2	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Exit Device (EO)	8810 EO	US32D	SA
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDWCSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO
1	Door Position Switch	By security contractor		OT
1	Sign by Owner	"Emergency Exit Only - Alarm Will Sound”		OT

3. Notes: NO HARDWARE SHALL BE PROVIDED ON WAREHOUSE SIDE OF THE DOOR. DOOR POSITION SWITCH SHALL BE PROVIDED BY SECURITY CONTRACTOR.

ZZ. Set: TI-06

1. Doors: WELLNESS ENTRY
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, CLASSROOM FUNCTION

4	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Kepad Lock	PBR NTM610 NR K660	626	YA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (HO)	7500H	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

3. Notes: GASKETING AT RATED OPENINGS. OMIT HOLD OPEN ARM ON CLOSER AT RATED OPENINGS. KEYPAD LOCK IS STAND-ALONE, BATTERY-OPERATED.

AAA. Set: TI-07

1. Doors: OFFICE, CONFERENCE ROOM
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, ENTRANCE/OFFICE FUNCTION, PUSH BUTTON INSIDE

3	Hinge	TA2714 NRP	US26D	MK
1	Entry/Office Lock	28 70 10G05 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO
1	Coat Hook	790	US26D	RO

3. Notes: GASKETING AT RATED OPENING. CLOSER AT RATED OPENING AND FIRST AID WAITING. COAT HOOK NOT REQUIRED FOR LOCKABLE CONFERENCE ROOMS.

BBB. Set: TI-07A

1. Doors: COMMAND CENTER, OPEN OFFICE ENTRY
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, ENTRANCE/OFFICE FUNCTION, PUSH BUTTON INSIDE

3	Hinge	TA2714 NRP	US26D	MK
1	Entry/Office Lock	28 70 10G05 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

CCC. Set: TI-08

1. Doors: CONFERENCE ROOM, STORAGE ROOM
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, PASSAGE FUNCTION

3	Hinge	TA2714 NRP	US26D	MK
1	Passage Latch	28 10U15 LP	US26D	SA
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

DDD. Set: TI-08A

1. Doors: CONFERENCE, JANITOR
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, PASSAGE FUNCTION

3	Hinge	TA2714 NRP	US26D	MK
1	Passage Latch	28 10U15 LP	US26D	SA
1	Surface Closer	(P)7500	689	NO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

EEE. Set: TI-09

1. Doors: JANITOR, TRAINING ROOM STORAGE, SHOVEL CLOSET WITH SINGLE DOOR
2. Description: INTERIOR DOOR | MECHANICAL LOCK, STOREROOM FUNCTION

3	Hinge	TA2714 NRP 28	US26D	MK
1	Storeroom Lock	70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (HO)	7500H	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050(-F) 34" H X 1" LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

3. Notes: GASKETING AT RATED OPENINGS. OMIT HOLD OPEN ARM ON CLOSER AT RATED OPENINGS.

FFF. Set: TI-09A

1. Doors: AV CLOSET, VENDING STORAGE
2. Description: 4' X 8' INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, STOREROOM FUNCTION

4	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Storeroom Lock	28 70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer (HO)	7500H	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

3. Notes: GASKETING AT RATED OPENINGS. OMIT HOLD OPEN ARM ON CLOSER AT RATED OPENINGS.

GGG. Set: TI-09B

1. Doors: MHE SHAFT – UNEVEN PAIR
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, STOREROOM FUNCTION

2	Continuous Hinge	CFM HD1		PE
1	Coordinator	2600 x FB	BLK	RO
2	Closer Mounting Bracket	2601AB/C as required	BLK	RO
1	Set Automatic Flush Bolt	2842/2942	US26D	RO
1	Dustproof Strike	570	US26D	RO
1	Mortise Exit Device	12 70 8904 ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
2	Surface Closer	PRO7500	689	NO
2	Surface Overhead Stop	9-X36	630	RF
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
2	Floor Stop	446	US26D	RO
2	Door Sweep	315CN		PE
1	Gasketing	S88D		PE
1	Overlapping Metal Astragal	357SP x S88D		PE

3. Notes: GASKETING AT RATED OPENINGS.

HHH. Set: TI-10

1. Doors: IDF ROOM
2. Description: INTERIOR DOOR | FUNCTION: ELECTRIFIED LEVER MORTISE LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT

2	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Electric Hinge, Hvy Wt	T4A3786-QC8	US26D	MK

1	Elec Mortise Lock (FAILSECURE) RX 70 8271-12V LNP			SA
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO
1	ElectroLynx Harness	QC-C300(P)		MK
1	Door Position Switch	By security contractor		OT
1	Card Reader	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR.

III. Set: TI-11

1. Doors: STAFFING AGENCY, ENS SITE ZONE 3
2. Description: INTERIOR DOOR | FUNCTION: ELECTRIFIED LEVER MORTISE LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT

2	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Electric Hinge, Hvy Wt	T4A3786-QC8	US26D	MK
1	Elec Mortise Lock (FAILSECURE) RX 70 8271-12V LNP		US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO
1	ElectroLynx Harness	QC-C300(P)		MK
1	Door Position Switch	By security contractor		OT
1	Card Reader	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR.

JJJ. Set: TI-11A

1. Doors: ENS PICKUP, TRAINING (DUTCH DOOR)
2. Description: ACCESS CONTROLLED CARD IN/CARD OUT HOLLOW METAL DUTCH DOOR | FUNCTION: TOP LEAF SECURED TO BOTTOM WITH EXIT LATCH. BOTTOM LEAF CARD IN/CARD OUT WITH SPRING HINGES

2	Hinge, Hvy Wt (TOP PANEL)	T4A3786 NRP	US26D	MK
2	Hinge, Spring (BOTTOM PANEL)	1502	US26D	MK

1	Fail Secure Lock	RX 28 70 10G71-12V LP	US26D	SA
1	Exit Latch	28 10G15-3 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2” LDW CSK	US32D	RO
1	Wall Stop	409	US32D	RO
1	Floor Stop	446	US26D	RO
4	Silencer	608-RKW		RO
1	Electric Power Transfer	EL-CEPT		SU
1	ElectroLynx Harness	QC-C306(P)		MK
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS ON LOWER LEAF. CARD READERS, DOOR POSITION SWITCHES, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR. THE TOP LEAF DOOR CONTACT SHALL BE PROGRAMMED AS INACTIVE WHEN THE INTRUSION DETECTION SYSTEM IS DISARMED.

KKK. Set: TI-12

1. Doors: STORAGE ROOM, ELEVATOR MACHINE ROOM, UTILITY ROOM
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, STOREROOM FUNCTION

3	Hinge	TA2714 NRP	US26D	MK
1	Storeroom Lock	28 70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

LLL. Set: TI-12A

1. Doors: HR STORAGE
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, STOREROOM FUNCTION

3	Hinge	TA2714 NRP	US26D	MK
1	Storeroom Lock	28 70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

MMM. Set: TI-13

1. Doors: BREAKROOM RATED PAIR
2. Description: INTERIOR EGRESS PAIR | FUNCTION: EXTERIOR LEVER, PASSAGE FUNCTION

6	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
2	CVR Fire Exit HW (PASSAGE)	12 NB MD8615 ETP	US32D	SA
2	Surface Closer (STOP)	CPS7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 1” LDWCSK	US32D	RO
2	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDWCSK	US32D	RO
1	Gasketing	S88D		PE
2	Sweep	315CN		PE
2	Meeting Stile Seal	305CN		PE

3. Notes: GASKETING AT RATED OPENING

NNN. Set: TI-13A

1. Doors: LOCKER ROOM/RESTROOM VESTIBULE TO WAREHOUSE EMERGENCY EXIT ONLY
2. Description: INTERIOR DOOR | FUNCTION: NO EXTERIOR TRIM, EMERGENCY EXIT ONLY, VERTICAL ROD EXIT DEVICES

6	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
2	CVR Fire Exit HW (EO)	12 NB MD8610 EO	US32D	SA
2	Surface Closer (STOP)	CPS7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 1” LDWCSK	US32D	RO
1	Gasketing	S88D		PE
2	Sweep	315CN		PE
2	Meeting Stile Seal	305CN		PE

OOO. Set: TI-13B

1. Doors: BREAK ROOM/RESTROOM VESTIBULE TO WAREHOUSE EMERGENCY EXIT ONLY
2. Description: INTERIOR DOOR | FUNCTION: NO EXTERIOR TRIM, EMERGENCY EXIT ONLY, RIM EXIT DEVICES X REMOVABLE MULLION

6	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Removable Lockable Mullion	12 L980S	PC	SA
2	Rim Fire Exit HW (EO)	12 8810 EO	US32D	SA
1	Mullion Cylinder Kit	70 980C1	US26D	SA
1	Permanent Keyed Core	By others	626	OT
2	Surface Closer (STOP)	CPS7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDWCSK	US23D	RO1
	Mullion Seal	5110BL		PE
1	Gasketing	S88D		PE
2	Sweep	315CN		PE
2	Meeting Stile Seal	305CN		

PPP. Set: TI-14

1. Doors: BREAKROOM NON RATED PAIR
2. Description: INTERIOR DOOR | FUNCTION: PUSH/PULL PLATES, NO LOCK FUNCTION

6	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
2	Pull Plate	110x70C 4" x 16"	US32D	RO
2	Push Plate	70G 4" x 20"	US32D	RO
2	Surface Closer	(P)7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 1" LDW		
2	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1" LDW		
2	Door Stop & Holder	472	US26D	RO
2	Silencer	608-RKW	RO	

QQQ. Set: TI-15

1. Doors: BREAKROOM SWING DOOR
2. Description: INTERIOR DOOR | FUNCTION: PUSH/PULL PLATES, NO LOCK FUNCTION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Pull Plate	110x70C 4" x 16"	US32D	RO
1	Push Plate	70G 4" x 20"	US32D	RO
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
1	Door Stop & Holder	472	US26D	RO
1	Edge Guard (LATCH EDGE)	EG308	630	MR
3	Silencer	608-RKW		RO

RRR. Set: TI-16

1. Doors: UNISEX TOILET ROOM
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, INDICATOR PRIVACY FUNCTION

3	Hinge	TA2714 NRP	US26D	MK
1	Indicator Privacy Lock	LB V21 8266 LNP	US26D	SA
1	Surface Closer	(P)7500	689	NO
1	Mop Plate (PULL SIDE)	K1050 10" H X 1” LDW CSK	US32D	RO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO
1	Coat Hook	790	US26D	RO
1	Sign	BF689 Unisex	Blue	RO

SSS. Set: TI-16A

1. Doors: NEW LACTATION ROOM PRIVATE
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, INDICATOR PRIVACY FUNCTION

3	Hinge	TA2714 NRP	US26D	MK
1	Indicator Privacy Lock	LB V21 8266 LNP	US26D	SA
1	Surface Closer	(P)7500	689	NO
1	Mop Plate (PULL SIDE)	K1050 10" H X 1” LDW CSK	US32D	RO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO
1	Coat Hook	790	US26D	RO

TTT. Set: TI-17

1. Doors: TRUCKERS' CAGE, HRV CAGE (WITH PANIC HARDWARE), HUB STAGING ACCESS FROM WAREHOUSE (FENCE)
2. Description: INTERIOR EGRESS | FUNCTION: ELECTRIFIED RIM EXIT DEVICE WITH EXTERIOR LEVER, FAIL SECURE

3	Hinges	By gate manufacturer		OT
1	Rim Exit Dev (ELEC LEVER, RX)	55 70 8876-24V ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	Surface Armored Door Cord	KEEDEX K-DL38A		KX
1	Power Supply	By security contractor		OT
1	Gate Plate Kit	GTPL x GTSTKBKT x DX GTPLGRD		
1	Gate Plate Kit	GTPL x GTSTKBKT x DX GTPLGRD (TRIM)		
1	Keedex Box	K-BX711150 by gate KX manufacturer		
1	Electrolynx Harness	QC-C1500P		MK
1	Wiring & Riser Diagram	By hardware supplier as required		

1. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. POWER SUPPLY, CARD READERS AND DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR. CARD READER TO SHUNT EGRESS ALARM.
2. GATE PLATE KIT INCLUDES PLATE (ADJUSTABLE FROM 32” TO 52” WIDE), STRIKE LATCH RECEIVER BRACKET, AND GATE LATCH PROTECTOR.
3. FENCE MANUFACTURER SHALL PROVIDE STEEL PLATE TO BLOCK ACCESS TO INTERIOR DOOR HARDWARE FROM UNSECURE SIDE. PLATE SHALL EXTEND 12" ABOVE AND BELOW AND TO BOTH SIDES OF DOOR HARDWARE.

FENCING MANUFACTURER TO PROVIDE STEEL PLATE ADJACENT TO GATE DOOR AND KEEDEX BOX FOR EXIT DEVICE TRIM. KEEDEX BOX TO BE MOUNTED 40” AFF TO CENTER OF BOX, FACE FLUSH WITH PUSH SIDE OF GATE. FENCING MANUFACTURER TO COORDINATE CLOSER MOUNTING SURFACE.

UUU. Set: TI-18

1. Doors: EMPLOYEE RESOURCE CENTER, MULTIFAITH, ABLUTION ROOM, LACTATION ROOM LOBBY
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, PASSAGE FUNCTION

3	Hinge	TA2714 NRP	US26D	MK
1	Passage Latch	28 10U15 LP	US26D	SA
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO

XV. Set: TI-19

1. Doors: OFF-SITE PARKING AREA RESTROOM, SNOW SHOVEL CLOSET

WWW. Set: TI-20

1. Doors: ELEC SWITCH, DEMARC (ENS), IT (ENS) ROOM, UTILITY ROOM (WHEN PANIC HARDWARE REQUIRED) - SINGLE
2. Description: INTERIOR EGRESS DOOR | FUNCTION: EXTERIOR LEVER, STOREROOM FUNCTION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Exit Device (STORE, LEVER)	70 8804 ETP	US32D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
3	Silencer	608-RKW		RO

3. Notes: PROVIDE FIRE RATED EXIT HARDWARE AND GASKETING AT RATED OPENINGS.

XXX. Set: TI-20A

1. Doors: ELEC SWITCH, DEMARC (ENS), IT (ENS) ROOM - PAIR
2. Description: INTERIOR EGRESS DOOR | FUNCTION: EXTERIOR LEVER, STOREROOM FUNCTION

6	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Removable Lockable Mullion	L980S	PC	SA
2	Rim Exit Device (STORE, LEVER)	70 8804 ETP	US32D	SA
1	Mullion Cylinder Kit	70 980C1	US26D	SA
1	Permanent Keyed Core	By others	626	OT
2	Surface Closer	(P)7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
2	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
2	Silencer	608-RKW		RO
1	Mullion Seal	5110BL		PE

3. Notes: PROVIDE FIRE RATED EXIT HARDWARE AND GASKETING AT RATED OPENINGS.

YYY. Set: TI-21

1. Doors: DEMARC ROOM
2. Description: INTERIOR DOOR | FUNCTION: ELECTRIFIED LEVER MORTISE LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT

2	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Electric Hinge, Hvy Wt	T4A3786-QC8	US26D	MK
1	Elec Mortise Lock(FAIL SECURE)	RX 70 8271-24V LNP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (INTERIOR SIDE)	K1050 10" H X 2" LDW CSK	US32D	RO
1	Armor Plate(Warehouse Side)	K1050 (-F) 34" H X 2" LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE
1	Sweep	315CN		PE
1	ElectroLynx Harness	QC-C300(P)		MK
1	Door Position Switch	By security contractor		CT
1	Card Reader	By security contractor		CT
1	Power Supply	By security contractor		CT
1	Wiring & Riser Diagram	By hardware supplier as re		

3. Notes: THRESHOLD REQUIRED IF BLDG IS NOT DRIED IN. ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR. ARMOR PLATE WAREHOUSE SIDE; KICK PLATE INTERIOR SIDE.

ZZZ. Set: TI-22

1. Doors: RECRUITMENT, STAFFING TELECOM ROOM
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, STOREROOM FUNCTION

3	Hinge	TA2714 NRP	US26D	MK
1	Storeroom Lock	28 70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE

AAAA. Set: TI-23

1. Doors: MDF, IT TEAM ROOM
2. Description: INTERIOR DOOR | FUNCTION: ELECTRIFIED LEVER MORTISE LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Electric Hinge, Hvy Wt	T4A3786-QC8	US26D	MK
1	Elec Mortise Lock (FAIL SECURE)	RX 70 8271-12V LNP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE
1	Sweep	315CN		PE
1	ElectroLynx Harness	QC-C400(P)		MK
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	Power Supply	By security contractor		OT
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: ACCESS BY AUTHORIZED CARD CREDENTIAL. ALWAYS FREE EGRESS. CARD READER, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR. AT NO TIME IS ANY TYPE OF WINDOW KIT ALLOWED IN THE MDF DOOR LEAF PER Tenant SECURITY REQUIREMENTS. THRESHOLD REQUIRED IF BUILDING IS NOT DRIED IN.

BBBB. Set: TI-24

1. Doors: RECRUITING OFFICE REST ROOM

2. Description: INTERIOR DOOR | FUNCTION: PUSH/PULL PLATES, NO LOCK FUNCTION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Pull Plate	110x70C 4" x 16"	US32D	RO
1	Push Plate	70G 4" x 20"	US32D	RO
1	Surface Closer	(P)7500	689	NO
1	Kick Plate (PUSH SIDE)	K1050 10" H X 2” LDW CSK	US32D	RO
1	Mop Plate (PULL SIDE)	K1050 10" H X 1” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
3	Silencer	608-RKW		RO
1	Sign	BF689 Unisex/BF688 Wm’s/BF687 Mn’s	BLUE	RO

CCCC. Set: TI-25

1. Doors: TEMPORARY IDF CAGE
2. Description: CAGE DOOR | FUNCTION: MECHANICAL LOCK, STOREROOM FUNCTION, FAIL SECURE ELECTRIC STRIKE

3	Hinges	By gate manufacturer		OT
1	Storeroom Lock	28 70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
1	Electric Strike (FAIL SECURE)	1006CS 24V	630	HS
1	Surface Closer	(P)7500	689	NO
1	Door Position Switch	By security contractor		OT
2	Card Reader	By security contractor		OT
1	Power Supply	By security contractor		SU
1	Latch Protector	320/321	US32D	RO
1	Keedex Box	K-BXRHO by gate manufacturer		KX
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: FENCE MANUFACTURER SHALL PROVIDE KEEDEX BOX AND STEEL PLATE TO BLOCK ACCESS TO INTERIOR DOOR HARDWARE FROM UNSECURE SIDE. PLATE SHALL EXTEND 12" ABOVE AND BELOW AND TO BOTH SIDES OF DOOR HARDWARE. CAGE FRAME SHALL INCLUDE STRIKE BOX SIZED TO ACCEPT ELECTRIC STRIKE. ELECTRIC STRIKE TO BE FAIL SECURE. CARD READER IN / OUT. CARD READER, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR.

DDDD. Set: TI-26

1. Doors: MAINTENANCE, SAFETY, DEMARC CAGE (NO ACCESS CONTROL)
2. Description: CAGE DOOR | FUNCTION: MECHANICAL LOCK, STOREROOM FUNCTION

3	Hinges	By gate manufacter		OT
1	Storeroom Lock	28 70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT

1	Surface Closer	(P)7500	689	NO
1	Door Position Switch	By security contractor		OT
1	Keedex Box	By gate manufacter	KX	

3. Notes: GATE MANUFACTURER SHALL PROVIDE KEEDEX BOX AND STEEL PLATE TO BLOCK ACCESS TO INTERIOR DOOR HARDWARE FROM UNSECURE SIDE. KEEDEX BOX TO BE MOUNTED 41” AFF TO CENTER OF BOX, FACE FLUSH WITH PUSH SIDE OF GATE. **STEEL PLATE SHALL EXTEND 12" ABOVE AND BELOW AND TO BOTH SIDES OF DOOR HARDWARE.** MOUNTING PLATE FOR CLOSER AND LOCKSET COORDINATION SHALL BE PROVIDED BY GATE MANUFACTURER.
4. DOOR POSITION SWITCH REQUIRED FOR SUPERVISED DEMARC CAGE ONLY.

EEEE. Set: TI-26A

1. Doors: IT, PARTS STOR, MSC, AR MAINT, HRV, DEMARC (ACCESS CONTROL, NO PANIC)
2. Description: CAGE DOOR | FUNCTION: ELECTRIFIED CYLINDRICAL LEVER LOCK, FAIL SECURE, INTEGRATED REQUEST TO EXIT

3	Hinges	By gate manufacturer		OT	
1	Fail Secure Lock	RX 28 70 10G71-24V LP	US26D	SA	⚡
1	Permanent Keyed Core	By others	626	OT	
1	Surface Closer	(P)7500	689	NO	
1	ElectroLynx Harness	QC-C1500(P)		MK	⚡
1	Door Position Switch	By security contractor		OT	
1	Surface Armored Door Cord	KEEDEX K-DL38A		KX	⚡
1	Card Reader (Qty varies)	By security contractor		OT	
1	Power Supply	By security contractor		SU	⚡
1	Latch Protector	320/321	US32D	RO	
1	Keedex Box	K-BXRHO by gate manuf		KX	
1	Wiring & Riser Diagram	By hardware supplier as required			

3. Notes: GATE MANUFACTURER SHALL PROVIDE KEEDEX BOX AND STEEL PLATE TO BLOCK ACCESS TO INTERIOR DOOR HARDWARE FROM UNSECURE SIDE. KEEDEX BOX TO BE MOUNTED 41” AFF TO CENTER OF BOX, FACE FLUSH WITH PUSH SIDE OF GATE. STEEL PLATE SHALL EXTEND 12" ABOVE AND BELOW AND TO BOTH SIDES OF DOOR HARDWARE. MOUNTING PLATE FOR CLOSER AND LOCKSET COORDINATION SHALL BE PROVIDED BY GATE MANUFACTURER. CARD READERS, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR.
4. AT ALL CAGES, THIS SET SHALL BE APPLIED ONLY TO PEDESTRIAN GATES. SLIDING GATES THAT LEAD INTO CAGES DO NOT REQUIRE ACCESS CONTROL OR ELECTRIFIED LOCKING HARDWARE.

FFFF. Set: TI-26B

1. Doors: SMOKERS' CANOPY GATE
2. Description: CAGE DOOR | FUNCTION: NO EXTERIOR TRIM, EMERGENCY EXIT ONLY

3	Hinges	By gate manufacturer		OT
1	Rim Exit Device (EO)	8810 EO	US32D	SA

1	Surface Closer	(P)7500	689	NO
1	Door Position Switch	By security contractor		OT
1	Gate Plate Kit	GTPL x GTSTKBKT x GTPLGRD		DX

3. Notes: FENCE MANUFACTURER SHALL PROVIDE MOUNTING PLATE FOR CLOSER. MOUNTING PLATE FOR CLOSER AND LOCKSET COORDINATION SHALL BE PROVIDED BY GATE MANUFACTURER. DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR.

GGGG. Set: TI-26C

1. Doors: SECURE ASSOCIATE PARKING GATE
2. Description: SECURE ASSOCIATE PARKING GATE | ELECTRONIC ACCESS CONTROLLED

3	Hinges	By gate manufacturer		OT
1	Rim Exit Device (ELECTRIFIED)	40 09DN LD ERxEXxW FC3EC1W 99	630	DE
1	Permanent Keyed Core	By others	626	OT
1	Rim/Mortise Cylinder	72 34/43 as required	US32D	SA
1	Surface Closer	(P)7500	689	NO
1	Door Position Switch	By security contractor		OT
1	Card Reader	By security contractor		OT
1	Outdoor Rated Power Supply	Waypoint3		AS
1	Gate Plate Kit	GTPL x GTSTKBKT x GTPLGRD		DE
1	Gate Plate Kit	GTPL x GTSTKBKT x GTPLGRD (TRIM)		DE
1	Keedex Box	K-BX711150 by gate manufacturer		KX
1	Wiring & Riser Diagram	By hardware supplier as required		

3. Notes: GATE MANUFACTURER SHALL PROVIDE KEEDEX BOX AND STEEL PLATE TO BLOCK ACCESS TO INTERIOR DOOR HARDWARE FROM UNSECURE SIDE. PLATE SHALL EXTEND 12" ABOVE AND BELOW AND TO BOTH SIDES OF DOOR HARDWARE. MOUNTING PLATE FOR CLOSER AND LOCKSET COORDINATION SHALL BE PROVIDED BY GATE MANUFACTURER. CARD READERS, DOOR POSITION SWITCH, AND POWER SUPPLY TO BE PROVIDED BY SECURITY CONTRACTOR.
4. AT ALL CAGES THIS SET SHALL BE APPLIED ONLY TO PEDESTRIAN GATES. SLIDING GATES THAT LEAD INTO CAGES DO NOT REQUIRE ACCESS CONTROL OR ELECTRIFIED LOCKING HARDWARE.

HHHH. Set: TI-26D

1. Doors: EMERGENCY EXIT ONLY DOUBLE CAGE DOOR
2. Description: CAGE DOOR | FUNCTION: NO EXTERIOR TRIM, EMERGENCY EXIT ONLY

6	Hinges	By gate manufacturer		OT
1	Fixed Mullion	By gate manufacturer		OT
2	Rim Exit Device (EO)	8810 EO	US32D	SA
2	Surface Closer	(P)7500	689	NO
2	Door Position Switch	By security contractor		OT
2	Gate Plate Kit	GTPL x GTSTKBKT x GTPLGRD		DE

3. Notes: FENCE MANUFACTURER SHALL PROVIDE MOUNTING PLATE FOR CLOSER. MOUNTING PLATE FOR CLOSER AND LOCKSET COORDINATION SHALL BE PROVIDED BY GATE MANUFACTURER. DOOR POSITION SWITCH TO BE PROVIDED BY SECURITY CONTRACTOR.
4. Notes: FENCE MANUFACTURER SHALL PROVIDE REMAINING REQUIRED HARDWARE. LOW VOLTAGE POWER, DOOR POSITION SWITCH, AND CARD READERS TO BE PROVIDED BY SECURITY CONTRACTOR.

JJJJ. Set: TI-26F

1. Doors: SLIDING FENCE GATE
2. Description: SLIDING METAL GATE | FUNCTION: ELECTRONIC ACCESS CONTROLLED

1	Sliding Gate Lock (Fail Safe)	GL 1-FSM		SU
1	Mortise Cylinder	70 43	US32D	SA
1	Permanant Keyed Core	By Others	626	OT
1	Emergency Door Release Button	EEB2		SU
2	Card Reader	By Security Contractor		OT
1	Power Supply	By Security Contractor		OT
1	Door Position Switch	By Security Contractor		OT
1	Key Switch	MKA		SU

3. Notes: FENCE MANUFACTURER SHALL PROVIDE REMAINING REQUIRED HARDWARE. LOW VOLTAGE POWER, DOOR POSITION SWITCH, AND CARD READERS TO BE PROVIDED BY SECURITY CONTRACTOR.

KKKK. Set: TI-27

1. Doors: EGRESS CORRIDOR PAIR
2. Description: INTERIOR EGRESS | EXTERIOR LEVER, PASSAGE FUNCTION

8	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
2	CVR Fire Exit HW (PASSAGE)	12 NB MD8615 ETP	US32D	SA
2	Surface Closer	(P)7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 1" LDW CSK	US32D	RO
2	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1" LDW CSK	US32D	RO
2	Electromagnetic Holder	998M (integrate into bldg's Fire alarm sys)	689	RF
1	Gasketing	S88D		PE
2	Sweep	315CN		PE
1	Meeting Stile Seal	S772D		PE

LLLL. Set: TI-28

1. Doors: STAIRWELL EGRESS CORRIDOR
2. Description: INTERIOR EGRESS | FUNCTION: EXTERIOR LEVER, PASSAGE FUNCTION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Fire Exit HW (PASSAGE)	12 8815 ETP	US32D	SA

1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE
1	Sweep	315CN		PE

MMMM. Set: TI-28A

1. Doors: STAIRWELL EGRESS CORRIDOR > 40" WIDE
2. Description: INTERIOR EGRESS | FUNCTION: EXTERIOR LEVER, PASSAGE FUNCTION

4	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Fire Exit HW (PASSAGE)	12 8815 ETP	US32D	SA
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2” LDW CSK	US32D	RO
1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
1	Floor Stop	446	US26D	RO
1	Gasketing	S88D		PE
1	Sweep	315CN		PE

NNNN. Set: TI-29

1. Doors: SHOVEL CLOSET PAIR
2. Description: INTERIOR DOOR | FUNCTION: MECHANICAL LOCK, STOREROOM FUNCTION

6	Hinge	TA2714 NRP	US26D	MK
2	Manual Flush Bolt	555	US26D	RO
1	Dust Proof Strike	570	US26D	RO
1	Storeroom Lock	28 70 10G04 LP	US26D	SA
1	Permanent Keyed Core	By others	626	OT
2	Surf Overhead Hold Open	9-_6	652	RF
2	Surface Closer	(P)7500	689	NO
2	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
2	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1” LDW CSK	US32D	RO
2	Floor Stop	446	US26D	RO
2	Silencer	608-RKW		RO

OOOO. Set: TI-30

1. Doors: EGRESS CORRIDOR SINGLE
2. Description: INTERIOR EGRESS | FUNCTION: EXTERIOR LEVER, PASSAGE FUNCTION

3	Hinge, Hvy Wt	T4A3786 NRP	US26D	MK
1	Rim Fire Exit HW (PASSAGE)	12 8815 ETP	US32D	SA
1	Surface Closer	(P)7500	689	NO
1	Armor Plate (PUSH SIDE)	K1050 (-F) 34" H X 2" LDW CSK	US32D	RO

1	Armor Plate (PULL SIDE)	K1050 (-F) 34" H X 1" LDW CSK	US32D	RO
1	Electromagnetic Holder	998M (integrate into bldg's Fire alarm sys)	689	RF
1	Gasketing	S88D		PE
1	Sweep	315CN		PE

PPPP. Set: TI-31

1. Doors: ALVARADO TURNSTILE
2. Description: TANDEM FULL HEIGHT TURNSTILE | FUNCTION: FAIL SECURE INGRESS, FAIL SAFE EGRESS, FIRE ALARM RELAY INTEGRATION REQUIRED

1	Hardware	Door manufacturer	OT

3. Notes: ARCHITECT SHALL CONFIRM TURNSTILE QUANTITIES BASED ON COMPOSITE DRAWING.

QQQQ. Set: TI-31A

1. Doors: BOON EDAM SPEEDLANE TURNSTILE
2. Description: TANDEM FULL HEIGHT TURNSTILE | FUNCTION: FAIL SECURE INGRESS, FAIL SAFE EGRESS, FIRE ALARM RELAY INTEGRATION REQUIRED

1	Hardware	Door manufacturer	OT

3. Notes: Architect SHALL CONFIRM LANE QUANTITIES BASED ON COMPOSITE DRAWING.

RRRR. Set: TI-32

1. Doors: MAIN EMPLOYEE ENTRY WITH AUTOMATIC OPERATOR
2. Description: ALUMINUM STOREFRONT PAIR | FUNCTION: EXTERIOR PULL, PASSAGE FUNCTION

2	Continuous Hinge w/cutout	CFM SLF-HD1		PE
2	Push Bar	47-PB	US32D	RO
2	Door Pull	BF157	US32D	RO
1	Automatic Door Operator	6061	689	NO
1	Surface Closer (TOP JAMB)	UNIJ7500	689	NO
1	Weatherseal	Door manufacturer		OT
2	Door Operator Switch	503		NO

3. Notes: ALWAYS FREE EGRESS AND ENTRY. CONFIRM OPERATOR SWITCH MOUNTING LOCATION, MOUNTING REQUIREMENTS, AND SWITCH TYPE PRIOR TO ORDER. PROVIDE POWER TO DOOR OPERATOR AND COORDINATE ROUGH-IN REQUIREMENTS WITH E.C.

SSSS. Set: TI-33

1. Doors: MAIN EMPLOYEE VESTIBULE PUSH/PULL

2. Description: ALUMINUM STOREFRONT PAIR | FUNCTION: EXTERIOR PULL, PASSAGE FUNCTION

2	Continuous Hinge w/cutout	CFM SLF-HD1		PE
2	Push Bar	47-PB	US32D	RO
2	Door Pull	BF157	US32D	RO
2	Surface Closer	UNI7500	689	NO
2	Drop Plate	7788	689	NO
2	Blade Stop Spacer Kit	6190/6191 as required	689	NO
1	Weatherseal	Door manufacturer		OT

3. Notes: ALWAYS FREE EGRESS AND ENTRY.

TTTT. Set: TI-34

1. Doors: SMOKER VESTIBULE
2. Description: ALUMINUM STOREFRONT SINGLE | FUNCTION: EXTERIOR PULL, PASSAGE FUNCTION

1	Continuous Hinge w/cutout	CFM SLF-HD1		PE
1	Push Bar	47-PB	US32D	RO
1	Door Pull	BF157	US32D	RO
1	Surface Closer	UNI7500	689	NO
1	Drop Plate	7788	689	NO
1	Blade Stop Spacer Kit	6190/6191 as required	689	NO
1	Weatherseal	Door manufacturer		OT

3. Notes: ALWAYS FREE EGRESS AND ENTRY.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other sections where glazing requirements are specified by reference to this section:

1. Windows.
2. Doors.
3. Glazed curtain walls.
4. Storefront framing.
5. Glazed entrances.

1.2 REFERENCE STANDARDS

A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; current edition.

B. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2011).

C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014.

D. ASTM C1036 - Standard Specification for Flat Glass;2011.

E. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2012.

F. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2013.

G. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2012a.

H. ASTM E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.

I. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2010.

J. GANA (GM) - GANA Glazing Manual; 2009.

K. GANA (SM) - GANA Sealant Manual; 2008.

1.3 RELATED REQUIREMENTS

A. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.4 SUBMITTALS - NOT USED

A. Florida Products Approvals: For products, components and assemblies for which Florida product approval is specified, submit Miami-Dade County NOA or Florida Building Control product approval showing compliance with the requirements of the Florida Building Code.

B. Material Test Reports: For windborne-debris-impact-resistance, submit reports by a qualified testing agency indicating compliance with requirements in the Contract Documents.

1.5 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Exterior Glazing Assemblies: Select type and thickness of exterior glass to withstand dead loads and wind loads acting normal to plane of glass at design pressures in accordance with adopted local codes and ordinances.

1. Use the procedure specified in ASTM E 1300 to determine glass type and thickness.
2. Limit glass deflection to 1/175 or 3/4 inch or flexure limit of glass, whichever is less, with full recovery of glazing materials.
3. Thicknesses listed are minimum.

C. Thermal movements: allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

D. Florida Building Code (FBC) Requirements:

1. Exterior building window and door assemblies shall have Miami-Dade County Product Control Notice of Acceptance (NOA) or Florida Building Code (FBC) Product Approval to meet the requirements of the current Florida Building Code as necessary to obtain permits required for acceptance of work by Authorities Having Jurisdiction.
2. Labeling: Exterior windows and doors shall be labeled in accordance with the requirements of the Florida Building Code.
3. Provide exterior enclosure assemblies approved for design pressures calculated in accordance with the Florida Building Code bearing FBC Product Approval numbers or Miami-Dade County NOA numbers for intended applications and functions of exterior assembly. Provide exterior enclosure assemblies tested as an assembly using components stated in product approval documents.
4. Verify acceptance of product approvals by Authorities Having Jurisdiction before fabrication or delivery. The various systems, in their fabrication and installation, shall comply with the approval acceptance criteria and supporting drawings and documentation.
5. Verify products or assemblies have product approval, that product approval numbers are valid and current, and that related construction assemblies and components are used to ensure approval by Authorities Having Jurisdiction. Where approval document numbers specified herein or associated products are not current or not otherwise applicable, notify the Architect by Request for Information (RFI) for clarification.
6. Approval criteria shall take precedence over specific product models and product requirements specified herein. Where components and characteristics associated with the approval documents differ with the requirements stated herein, the approved requirements shall govern and shall be provided.

E. Windborne-Debris Impact Resistance: Provide exterior glazing that passes basic-protection testing requirements in ASTM E 1996 when tested according to ASTM E 1886.

1. Large Missile Test: For glazing located within 30 feet of grade.
2. Small Missile Test: For glazing located more than 30 feet above grade.

F. Installed glazing systems shall comply with requirements of IBC 2406.3 “Identification of Safety Glazing.”

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with GANA Glazing Manual and FGMA Sealant Manual for glazing installation methods.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.7 WARRANTY

A. See Section 017700 - Closeout Submittals, for additional warranty requirements.

B. Sealed Insulating Glass Units: Provide a five (5) year warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.

PART 2 - PRODUCTS

2.1 GLASS MATERIALS

A. Float Glass: Provide float glass based glazing unless noted otherwise.

1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality-Q3.
2. Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and Kind FT.
3. Thicknesses: As indicated; for exterior glazing comply with requirements indicated for wind load design regardless of thickness indicated.

2.2 GLAZING UNITS

A. Type A and AT - Single Vision Glazing:

1. Application: All interior glazing unless otherwise indicated.
2. Type: Annealed and fully tempered, as indicated on drawings float glass.
3. Tint: Clear.
4. Thickness: 1/4 inch.

B. Type G-10 Safety Wired Glazing: Flat glass with embedded wire mesh.:

1. Application: Locations as indicated on drawings.
2. Form: No. 1 - Polished both sides; ASTM C1036.
3. Mesh: M1 - Diamond ASTM C1036.
4. Tint: Clear.
5. Glass Type: Annealed.
6. Thickness: 1/4 inch, nominal.

2.3 INSULATING GLASS UNITS

A. Type D and DT - Sealed Insulating Glass Units: Vision glazing, with Low-E coating.

1. Application: All exterior glazing unless otherwise indicated.
2. Between-lite space filled with air.
3. Thermal Resistance (U-Value): 0.29, nominal.
4. Total Solar Heat Gain Coefficient: 0.25, nominal.
5. Total Visible Light Transmittance: 34 percent to 37percent.
6. Basis of Design: PPG Industries, Inc: www.ppgideascapes.com.
7. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.

    a. Low E Coating: PPG Solarban 60 on # 2 surface, no coating on #3 surface.
    b. Tint: Solargray.

8. Inboard Lite: Annealed float glass, 1/4 inch thick.

    a. Tint: Clear.

9. Total Unit Thickness: 1 inch.; 1/4 inch thick tempered inner and outer panes, with 1/2 inch air space

10. Total Unit Thickness: 1-1/4 inches, 1/4 inch thick tempered outer pane, 9/16 inch thick laminated inner pane, with 1/2 inch air space.

2.4 GLAZING SEALANTS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

B. Glazing sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, type S, GRADE NS, CLASS 50, USE NT.

2.5 UNFRAMED MIRROR

A. 6 mm (1/4 inch) minimum thickness, mirror glazing quality plate or float glass with silver coating and electrolytically copper plated back. Grind and polish all edges.

2.6 ACCESSORIES

A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long x one half the height of the glazing stop x thickness to suit application, self-adhesive on one face.

C. Glazing Tape: Back-bedding mastic glazing tapes: Preformed, black, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800.

D. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; Black color.

E. Glazing Clips: Manufacturer's standard type.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

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

3.2 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant.

D. Install sealants in accordance with ASTM C1193 and GANA Sealant Manual.

E. Install sealants in accordance with manufacturer's instructions.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from project site and legally dispose of off project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

3.4 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of project not more than four days before date scheduled for inspections that establish date of substantial completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088800

SECTION 090561 - COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section applies to all floors identified in the contract documents as to receive the following types of floor coverings:

    a. Resilient tile.
    b. Carpet
    c. Seamless Quartz Flooring

2. Removal of existing floor coverings.
3. Preparation of existing concrete floor slabs for installation of floor coverings.
4. Testing of concrete floor slabs for moisture and alkalinity (ph).
5. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (ph) conditions.

    a. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 017419 - Construction Waste Management And Disposal: handling of existing floor coverings removed.
3. Section 039300 – Concrete Rehabilitation
4. Section 096726 – Seamless Quartz Flooring

1.2 REFERENCES

A. ASTM C109/C109M - Standard Test Method For Compressive Strength Of Hydraulic Cement Mortars (Using 2-In. Or (50-Mm) Cube Specimens); 2013.

B. ASTM C472 - Standard Test Methods For Physical Testing Of Gypsum, Gypsum Plasters And Gypsum Concrete; 1999 (Reapproved 2014).

C. ASTM F710 - Standard Practice For Preparing Concrete Floors To Receive Resilient Flooring; 2011.

D. ASTM F1869 - Standard Test Method For Measuring Moisture Vapor Emission Rate Of Concrete Subfloor Using Anhydrous Calcium Chloride; 2011.

E. RFCI (RWP) - Recommended Work Practices For Removal of resilient Floor Coverings; Resilient Floor Covering Institute; October 2011.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.4 QUALITY ASSURANCE

A. Contractor may perform adhesive and bond test with his own personnel or hire a testing agency.

B. Remedial coating installer qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer, and able to provide at least 3 project references showing at least 3 years' experience installing moisture emission coatings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect products in accordance with manufacturer's instructions and recommendations.

B. Deliver materials in manufacturer's packaging; include installation instructions.

C. Keep materials from freezing.

1.6 FIELD CONDITIONS

A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.

B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Patching compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:

1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
2. Compressive strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.

B. Alternate flooring adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and ph conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.

C. Remedial floor coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring

manufacturer's emission limits, resistant to the level of alkalinity (ph) found, and suitable for adhesion of flooring without further treatment.

1. If testing agency recommends any particular products, use one of those.
2. Products:

    a. Ardex Engineered Cements; Ardex MC Ultra with Ardex Feather Finish: www.ardexamericas.com
    b. Custom Building Products; TechMVC moisture vapor and alkalinity barrier: www.custombuildingproducts.com

PART 3 - EXECUTION

3.1 CONCRETE SLAB PREPARATION

A. Perform following operations in the order indicated:

1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:

    a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
    b. Removal of existing floor covering.

2. Preliminary cleaning.
3. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
4. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
5. Alkalinity (ph) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
6. Specified remediation, if required.
7. Patching, smoothing, and leveling, as required.
8. Other preparation specified.
9. Adhesive bond and compatibility test.
10. Protection.

B. Remediations:

1. Active water leaks or continuing moisture migration to surface of slab: Correct this condition before doing any other remediation; re-test after correction.
2. Excessive moisture emission or relative humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; If not, apply remedial floor coating over entire suspect floor area.
3. Excessive alkalinity (ph): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.2 REMOVAL OF EXISTING FLOOR COVERINGS

A. Comply with local, state, and federal regulations and recommendations of RFCI recommended work practices for removal of resilient floor coverings, as applicable to floor covering being removed.

B. Dispose of removed materials in accordance with local, state, and federal regulations and as specified.

3.3 PRELIMINARY CLEANING

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

3.4 MOISTURE VAPOR EMISSION TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method comply with the requirements of this section.

C. Test in accordance with ASTM F1869 and as follows.

D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer’s limits perform remediation as indicated. In the absence of manufacturer limits perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.

F. Report: Report the information required by the test method.

3.5 ALKALINITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. The following procedure is the equivalent of that described in ASTM F710, repeated here for the contractor's convenience.

C. Use a wide range alkalinity (ph) test paper, its associated chart, and distilled or deionized water.

D. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (ph) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (ph) reading.

E. In the event that test values exceed floor covering manufacturer’s limits perform remediation as indicated. In the absence of manufacturer limits perform remediation if alkalinity (ph) test value is over 10.

3.6 PREPARATION

A. See individual floor covering section(s) for additional requirements.

B. Comply with requirements and recommendations of floor covering manufacturer.

C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.

D. Do not fill expansion joints, isolation joints, or other moving joints.

3.7 ADHESIVE BOND AND COMPATIBILITY TESTING

A. Comply with requirements and recommendations of floor covering manufacturer.

3.8 APPLICATION OF REMEDIAL FLOOR COATING

A. Comply with requirements and recommendations of coating manufacturer.

3.9 PROTECTION

A. Cover prepared floors with building paper or other durable covering.

END OF SECTION 090561

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SECTION 092116 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Performance criteria for gypsum board assemblies.
2. Acoustic insulation.
3. Gypsum wallboard.
4. Joint treatment and accessories.

B. Related Requirements:

1. Section 061000 - "Rough Carpentry: Wood Blocking Product And Execution Requirements.
2. Section 072100 – Thermal Insulation: Thermal and acoustic wall insulation.
3. Section 078413 – Penetration Firestopping: Top-Of-Wall Assemblies At Fire Rated Walls.
4. Section 079200 - Joint Sealers: Acoustic Sealant.
5. Section 092216 – Non-Structural Metal Framing

1.2 REFERENCE STANDARDS

A. ASTM C475/C475M - Standard Specification For Joint Compound And Joint Tape For Finishing Gypsum Board; 2015.

B. ASTM C754 - Standard Specification For Installation Of Steel Framing Members To Receive Screw-Attached Gypsum Panel Products; 2015.

C. ASTM C840 - Standard Specification For Application And Finishing Of Gypsum Board; 2013.

D. ASTM C954 - Standard Specification For Steel Drill Screws For The Application Of Gypsum Panel Products Or Metal Plaster Bases To Steel Studs From 0.033 In. (0.84 mm) To 0.112 In. (2.84 mm) In Thickness; 2015.

E. ASTM C1002 - Standard Specification For Steel Self-Piercing Tapping Screws For Application Of Gypsum Panel Products Or Metal Plaster Bases To Wood Studs Or Steel Studs; 2014.

F. ASTM C1047 - Standard Specification For Accessories For Gypsum Wallboard And Gypsum Veneer Base; 2014A.

G. ASTM C1278/C1278M - Standard Specification For Fiber-Reinforced Gypsum Panel; 2007A (Reapproved 2011).

H. ASTM C1396/C1396M - Standard Specification For Gypsum Board; 2014.

I. ASTM D3273 - Standard Test Method For Resistance To Growth Of Mold On The Surface Of Interior Coatings In An Environmental Chamber; 2012.

J. ASTM E90 - Standard Test Method For Laboratory Measurement Of Airborne Sound Transmission Loss Of Building Partitions And Elements; 2009.

K. ASTM E413 - Classification For Rating Sound Insulation; 2010.

L. GA-216 - Application And Finishing Of Gypsum Board; Gypsum Association; 2013.

M. GA-600 - Fire Resistance Design Manual; Gypsum Association; 2015.

N. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; Current Edition.

1.3 QUALITY ASSURANCE

A. Installer qualifications: company specializing in performing gypsum board application and finishing, with minimum 5 years of documented experience.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide completed assemblies complying with ASTM C840 and GA-216.

B. Interior partitions indicated as acoustic: Provide completed assemblies with the following characteristics:

1. Acoustic attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

C. Fire rated assemblies: Provide completed assemblies with the following characteristics:

1. Fire rated partitions: UL listed assembly; 2-hour rating.
2. UL assembly numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.2 MATERIALS

A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.

1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
2. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
3. Thickness:

a. Vertical Surfaces: 5/8 inch.
b. Ceilings: 5/8 inch.

4. Paper-Faced Products:

a. USG Corporation; Sheetrock Brand Gypsum Panels.

1) Regular Type: "SHEETROCK Brand Gypsum Panels", at interior non-rated partitions and soffits.
2) Fire-Rated Panels: "SHEETROCK Firecode (Type X) and Firecode C Cores Panels" at interior rated partitions, soffits, and ceilings.
3) Water-resistant Panels: ASTM C1396/C1396M, "Fiberock Brand Aqua-Tough Panels", at interior janitor room walls, restroom "wet" walls, and walls to receive ceramic tile. Provide Type X fire-resistant type where required to meet rated assembly requirements.

4) Mold Resistant Panels: "SHEETROCK Brand Mold Tough Gypsum Panels", with moisture and mold-resistant gypsum core encased in moisture resistant papers, at all interior surfaces of exterior walls.
5) Cement Backer Board: "DUROCK Cement Board" at walls to receive ceramic tile. Materials: Aggregated Portland cement with woven glass fiber mesh facing complying with ANSI A118.9.
6) Water-Resistant Backing Board (WR): ASTM C1396/C1396M, regular types unless noted otherwise. Provide Type X for fire-resistant rated assemblies.

B. Mold Resistant Wallboard: Moisture and mold-resistant gypsum core encased in moisture resistant papers.

1. Application: At all interior surfaces of exterior walls.
2. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.

a. Thickness: 5/8 inch.

3. Products:

a. USG Corporation: Sheetrock Brand Mold Tough Gypsum Panels.

C. Backing Board For Wet Areas:

1. Application: Surfaces behind tile in wet areas including tub and shower surrounds and shower ceilings.
2. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.

a. Thickness: 1/4 inch.
b. Products:

1) USG Corporation; Durock: www.usg.com.

D. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.

1. Application: Vertical surfaces behind thinset tile, except in wet areas, restroom walls, and janitor room walls.
2. Type: Regular and Type X, in locations indicated.
3. Type X Thickness: 5/8 inch.
4. Regular Board Thickness: 5/8 inch.
5. Edges: Tapered.
6. Products:

a. USG Corporation; Fiberock Aqua-Tough Interior Panels.

E. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.

1. Application: Ceilings, unless otherwise indicated.
2. Thickness: 1/2 inch.
3. Edges: Tapered.
4. Products:

a. USG Corporation; Sheetrock Brand Sag-Resistant Interior Gypsum Ceiling Board.

F. Shaftwall Liner: ASTM C 1396, Type X; 1 inch thick, fire resistant gypsum core shaftwall liner panel with water-repellent paper facings.

1. Shaft Liner Gypsum Wallboard by American Gypsum.
2. Gold Bond Fire-Shield Shaftliner by National Gypsum.
3. Sheetrock Brand Gypsum Liner Panels by United States Gypsum

2.3 ACCESSORIES

A. Moldings and Reveals: Extruded aluminum drywall trim. Size and shape as indicated on the drawings.
1. Flexible Corner Trim: "SHEETROCK Brand Flex Metal Tape (Flex Tape)" with two 7/16-inch (11.11mm) wide galvanized rust-resistant steel strips with 1/16-inch (1.59mm) gap between the strips. Form to fit inside or outside angles greater or less than 90 degrees. Provide width to suit application.
2. Paper Faced Trim Accessories: Paper faced trim accessories by Drywall Systems International. Products with comparable performance characteristics by Dietrich Metal Framing and U.S.G. Corp. are acceptable.
a. Paper Faced Trim Accessories: "No-Coat Paper Faced Trims", latex saturated paperboard laminated to proprietary copolymer plastic and paper joint tape.

B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

C. Acoustic Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board.

D. Water-Resistive Barrier:

E. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.

F. Types: As detailed or required for finished appearance.

G. Special Shapes: In addition to conventional corner bead and control joints, provide U- bead at exposed panel edges.
1. Corner bead: "DUR-A-BEAD Corner Bead" No. 103, all-metal, galvanized steel reinforcement with 1-1/4-inch x 1-1/4-inch (32mm x 32mm) flange width. Use at standard 90 degree outside corners unless otherwise indicated.
2. J-Bead: No 200-A, J-shaped galvanized steel casing.
3. L-Bead: No. 200-B, L-shaped galvanized steel casing.
4. Expansion (Control) Joint: "Zinc Control Joint No. 093", roll-formed zinc with tape-protected opening 1/4-inch (6.35mm) wide x 7/16-inch (11.11mm) deep.

H. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.

I. Tape: 2 inch wide, coated glass fiber tape for joints and corners.

J. Ready-mixed vinyl-based joint compound.

K. Screws: ASTM C 1002; self-piercing tapping type; cadmium-plated for exterior locations.

L. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.2 INSTALLATION

A. Comply with ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-layer non-rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

1. Exception: Tapered edges to receive joint treatment at right angles to framing.

C. Double-layer non-rated: Use gypsum board for first layer placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.

D. Fire-rated construction: Install gypsum board in strict compliance with requirements of assembly listing.

E. Installation on metal framing: Use screws for attachment of gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination.

F. Installation at ceiling locations: Gypsum shall be attached to framing with screws at a minimum distance of every 8 inches.

3.3 INSTALLATION OF TRIM AND ACCESSORIES

A. Control joints: Place control joints consistent with lines of building spaces and as follows:

1. Not more than 30 feet apart on walls and ceilings over 50 feet long.

B. Corner beads: Install at external corners, using longest practical lengths.

C. Edge trim: Install at locations where gypsum board abuts dissimilar materials.

3.4 JOINT TREATMENT

A. Paper faced gypsum board: Use paper joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.

B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:

1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
2. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.

3. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.

C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.

1. Feather coats of joint compound so that camber is maximum 1/32 inch.

D. Where level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.5 TOLERANCES

A. Maximum variation of finished gypsum board surface from true flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION 092116

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal partition, ceiling, and soffit framing
2. Framing accessories.

B. Related Requirements

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 092116 – Gypsum Board Assemblies

1.2 REFERENCE STANDARDS

A. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products

B. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

PART 2 PRODUCTS

2.2 FRAMING MATERIALS

A. Non-Loadbearing Framing System Components: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf at interior and L/360 at 20 psf for exterior locations.

1. Studs: ClarkWestern ProSTUD. C shaped with flat or formed webs
2. Runners: U shaped, sized to match studs.
3. Ceiling Channels: C shaped.
4. Furring: Hat-shaped sections, minimum depth of 7/8 inch.

B. Partition Head to Structure Connections: Provide extended leg track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short.

C. Tracks and Runners: Same material and thickness as studs or heavier per design requirements, bent leg retainer notched to receive studs.

D. Furring and Bracing Members: Of same material as studs; thickness to suit purpose; complying with applicable requirements of ASTM C754.

E. Fasteners: ASTM C1002 self-piercing tapping screws.

F. Anchorage Devices: Power actuated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

3.2 PARTITION INSTALLATION

A. Comply with requirements of ASTM C754.

B. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

C. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs as indicated.

D. Align and secure top and bottom runners at 24 inches on center.

E. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.

F. Install studs vertically at spacing indicated on drawings.

G. Align stud web openings horizontally.

H. Secure studs to tracks using fastener method. Do not weld.

I. Fabricate corners using a minimum of three studs.

J. Double stud at wall openings, door and window jambs, not more than 2 inches from each side of openings.

K. Brace stud framing system rigid.

L. Coordinate erection of studs with requirements of door frames; install supports and attachments.

M. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.

3.3 CEILING AND SOFFIT FRAMING

A. Comply with requirements of ASTM C754.

B. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.

C. Install furring independent of walls, columns, and above-ceiling work.

D. Securely anchor hangers to structural members or embed in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.

E. Space main carrying channels at maximum 48 inch on center, and not more than 6 inches from wall surfaces. Lap splice securely.

F. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.

G. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.

H. Reinforce openings in suspension system that interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 24 inches past each opening.

END OF SECTION 092216

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SECTION 093000 - TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes ceramic tile, tile backing panels, waterproof membrane, crack isolation membrane, and all related accessories.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 Specification sections which apply to this section.

B. Section 016116 – Volatile Organic Compound (VOC) Restrictions

C. Section 079200 – “Joint Sealants” for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, ANSI A108.17, ANSI A108.19, and ANSI 137.3 which are contained in "American National Standard Specifications for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.

1.4 PERFORMANCE REQUIREMENTS

A. Static coefficient of friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level surfaces: Minimum .60 COF.

1.5 QUALITY ASSURANCE

A. Source limitations for tile: Obtain tile of each type and color or finish from one source or producer.
1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:

1. Waterproof membrane.
2. Crack isolation membrane.
3. Joint sealants.

1.6 PROJECT CONDITIONS

A. Environmental limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Upon delivery, inspect materials for damage. If damage is discovered, immediately file a claim with supplier. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained, and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.8 MAINTENANCE MATERIALS (CLOSEOUT)

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and trim units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI ceramic tile standard: provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with standard grade requirements unless otherwise indicated.
2. Provide extra tile to be left on site for future repairs

a. Minimum 10% extra per tile size, style, color.
b. Coordinate location for storage with Owner’s site lead personnel.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

2.2 TILE PRODUCTS

A. Basis-of-design products: Subject to design requirements, provide products as indicated in Drawings

2.3 TILE BACKING PANELS

A. Cementitious backer units: ANSI A118.9 or ASTM C 1325, in maximum lengths available to minimize end-to-end butt joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include the following:

a. C-Cure; C-Cure Board 990.
b. Custom Building Products; Wonderboard.
c. Finpan, Inc.; Util-a-Crete concrete backer board.
d. USG Corporation; Durock cement board.

2. Thickness: 5/8 inch.

2.4 WATERPROOFING MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement, accessories, and sealant recommended by manufacturer.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.

1. Products: Subject to compliance with requirements, provide the following:

a. Noble Company (The); Nobleseal TS.

2.5 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.

1. Products: Subject to compliance with requirements, provide the following:

a. Noble Company (The); Nobleseal CIS.

2.6 SETTING MATERIALS

A. Latex-portland cement mortar (thin set): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include the following:

a. Bonsal American; an Oldcastle Company.
b. Bostik, Inc.

c. Laticrete International, Inc.
d. Mapei Corporation.
e. TEC; a subsidiary of H. B. Fuller Company.

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.7 GROUT MATERIALS

A. Polymer-modified tile grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include the following:

a) Same as above

2. Polymer type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.

B. Water-cleanable epoxy grout: ANSI A118.3. To be used in all tiled areas where food service or food sales take place manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include the following:

1. CEGG-Lite 100% Solids Commercial Epoxy Grout by Custom Building Products
2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F (60 deg C) and 212 deg F (100 deg C), respectively, and certified by manufacturer for intended use.

2.8 MISCELLANEOUS MATERIALS

A. Trowelable underlayments and patching compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Tile cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

C. Grout sealer: Manufacturer's standard penetrating silicone product for sealing grout joints and that does not change color or appearance of grout.

D. Products: Subject to compliance with requirements, available products that may be incorporated into the work include the following:

1. Bonsal American; an Oldcastle Company; grout sealer.
2. Mapei Corporation; 004, Keraseal Penetrating Sealer for unglazed grout and tile.
3. TEC; a subsidiary of H. B. Fuller Company; TA-256 penetrating silicone grout sealer.

2.9 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

2.10 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Section 079200, "Joint Sealants."

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.

C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

1. Products: Subject to compliance with requirements, provide one of the following:

a. DAP Inc.; Titanium Enriched Kitchen and Bath Sealant.
b. Dow Corning Corporation; Dow Corning 786.
c. GE Silicones; a division of GE Specialty Materials; Sanitary 1700.
d. Laticrete International, Inc.; Latasil Tile & Stone Sealant.
e. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
f. Tremco Incorporated; Tremsil 600 White.

D. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.

1. Products: Subject to compliance with requirements, provide one of the following:
a. Bostik, Inc.; Chem-Calk 550.
b. Degussa Building Systems; Sonneborn Sonolastic SL 2.
c. Pecora Corporation; Dynatrol II-SG.
d. Sika Corporation; Sikaflex-2c SL.
e. Tremco Incorporated.; THC-900.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with adhesives or thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at project site before installing.

D. Field-applied temporary protective coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 TILE INSTALLATION

A. Comply with TCA's "Handbook For Ceramic Tile Installation" for TCS installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications For Installation Of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Jointing pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

E. Joint widths: Unless otherwise indicated, install tile with the following joint widths:

1. Ceramic mosaic tile: 1/8 inch (3.2 mm).
2. Paver tile: 3/16 inch (48 mm).
3. Glazed wall tile: 1/16 inch (1.6 mm).

F. Expansion joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

G. Metal edge strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

H. Grout sealer: Apply grout sealer to cementitious grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 WATERPROOFING INSTALLATION

A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.

B. Do not install tile or setting materials over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

3.5 CRACK ISOLATION MEMBRANE INSTALLATION

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness and bonded securely to substrate.

B. Do not install tile or setting materials over crack isolation membrane until membrane has cured.

3.6 CLEANING AND PROTECTION

A. Cleaning: On completion of placement and grouting, clean all tile surfaces so they are free of foreign matter.

1. Remove epoxy grout residue from tile immediately after installation.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.7 ADDITIONAL EPOXY GROUT CLEANING INFORMATION

A. PROCEDURE

1. Grout release specified above shall be applied to tiles prior to grouting. This is an essential step to allow for complete epoxy grout clean up.
2. Following epoxy grout installation, immediately remove epoxy grout residue from tile.
3. Clean epoxy grout from tiles using a 175 rpm orbital cleaning machine with white scrubbing/polishing pads. Very hot, soapy water is to be used for this step.
4. Following orbital cleaning machine step, wipe tile clean with a standard sponge. Discard sponge after approximately 30 square feet of cleaning. Replace sponge frequently to avoid smearing epoxy rather than cleaning it off.
5. Following sponge cleaning, use a soft cloth (bath towel size) with very hot water to “drag clean” the remaining grout residue. Rinse towel in very hot water every 50 square feet of cleaning. Do not reuse towel on subsequent days, and for no more than 300 square feet of cleaning overall.

END OF SECTION 093000

SECTION 095113 – ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Suspended metal grid ceiling system, acoustical panels, and related accessories.

B. Related Requirements:

1. Section 017823 - Operations and Maintenance Data.
2. Section 079200 - Joint Sealers: Acoustical Sealant.
3. Mechanical and Electrical drawings

1.2 REFERENCE STANDARDS

A. ASTM C635/C635M - Standard Specification For The Manufacture, Performance, And Testing Of Metal Suspension Systems For Acoustical Tile And Lay-In Panel Ceilings; 2013A.

B. ASTM C636/C636M - Standard Practice For Installation Of Metal Ceiling Suspension Systems For Acoustical Tile And Lay-In Panels; 2013.

C. ASTM E1264 - Standard Classification For Acoustical Ceiling Products; 2014.

D. NFPA 286 - Standard Methods Of Fire Tests For Evaluating Contribution Of Wall And Ceiling Interior Finish To Room Fire Growth; 2015.

E. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; Current Edition.

1.3 SUBMITTALS

A. Product Data. Provide manufacturer’s product data for suspension systems, showing all components.

B. Shop Drawings: Show the following:

1. Layout of grid components and hanger spacing, including perimeter support wires.
2. Locations and methods of attachment of grid to walls. Clearance where grid is not attached to walls.
3. Connection of ends of main beams and cross tees.
4. Locations and details of compression struts and horizontal restraint wires or rigid bracing.
5. Locations and details of seismic separation joints.
6. Bracing for changes in ceiling plane.
7. Locations and support details for light fixtures, diffusers, and other items within the ceiling system.

C. Evaluation Report: ICC-ES report verifying code compliance for systems with alternative materials, design or methods of construction not specifically prescribed by the building code.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Do not install acoustical units until after interior wet work is dry.

1.5 QUALITY ASSURANCE

A. Fire-resistive assemblies: Complete assembly listed and classified by UL (FRD) for the fire resistance indicated.

B. Suspension system manufacturer qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Acoustical unit manufacturer qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.6 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 - PRODUCTS

2.1 ACOUSTICAL UNITS

A. Manufacturers:

1. Armstrong World Industries, Inc; www.armstrong.com
2. CertainTeed Corp. – www.certainteed.com
3. Celotex Corp.
4. USG Interiors: www.usg.com
5. Substitutions: none allowed

B. Acoustical units - general: ASTM E1264, class A.

1. Units for installation in fire-rated suspension system: Listed and classified for the fire-resistive assembly as part of suspension system.

C. Acoustical tile: Painted mineral fiber, ASTM E1264 type III, with the following characteristics:

1. Armstrong (Ceiling and Wall Solutions) – Cortega (Basis of Design)
   a. Cortega 770 – 24” x 24”
   b. Cortega 769 – 24” x 48”
   c. Size: As noted on drawings
   d. Use other sizes only when required to match existing conditions
   e. Thickness: 5/8 inches
   f. Composition: Wet-formed Mineral fiber
   g. Light reflectance: 0.80, determined in accordance with ASTM E1477-98A
   h. NRC: 0.55, determined as specified in ASTM E1264

i. Ceiling attenuation class (CAC): Min. 35, determined in accordance
j. Fire rating: Class A
k. Edge: Square lay-in
l. Surface color: As indicated on the Drawings.
m. Surface pattern: Medium Texture
n. Provide extra tile to be left on site for future repairs
    1) Minimum 10% extra per tile size and style.
    2) Coordinate location for storage with Owner's site lead personnel.

2. Armstrong (Ceiling and Wall Solutions) – Cermaguard (Basis of Design – washable ceilings)
    a. Cermaguard 607 – 24" x 24"
    b. Cermaguard 608 – 24" x 48"
    c. Size: As noted on drawings
    d. Use other sizes only when required to match existing conditions
    e. Thickness: 5/8 inches
    f. Composition: Wet-formed ceramic and Mineral fiber
    g. Light reflectance: 0.79, determined in accordance with ASTM E1477-98A
    h. NRC: 0.55, determined as specified in ASTM E1264
    i. Ceiling attenuation class (CAC): Min. 40, determined in accordance
    j. Fire rating: Class A / Fire Guard
    k. Edge: Square lay-in
    l. Surface color: As indicated on the Drawings.
    m. Surface pattern: Fine Fissured
    n. Treatments: Anti-Mold / Mildew treatment to resist the growth of mold and mildew on the tile surface.
    o. Provide extra tile to be left on site for future repairs
        1) Minimum 10% extra per tile size and style.
        2) Coordinate location for storage with Owner's site lead personnel.

2.2 SUSPENSION SYSTEM(S)

A. Manufacturers:

1. Same as for acoustical units, or as indicated below:
2. Chicago Metallic Corporation: www.chicagometallic.com.
3. Substitutions: See Section 012500 – Substitution Procedure.

B. Suspension systems - general: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.

C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Override (stepped) type.

3. Face Design: Flat, flush.
4. Cap Material: Steel cold-rolled sheet.
5. Cap Finish: As indicated on the Drawings.

2.3 METAL EDGE MOULDINGS AND TRIM

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

1. Armstrong World Industries, Inc.
2. CertainTeed Corp.
3. Chicago Metallic Corporation.
4. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
3. Edge Trim: Face width as indicated on drawings. 9/16” horizontal legs with hems formed for attachment to mounting clips. Commercial quality cold-rolled 24 gauge steel, factory finished in manufacturers standard color.

2.4 ACCESSORIES

A. Support channels and hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

1. Hanger wire shall be 12 gage galvanized wire, specifically manufactured for use with suspended ceilings.

B. Perimeter moldings: Same material and finish as grid.

1. At exposed grid: Provide L-shaped molding for mounting at same elevation as face of grid.

C. Acoustical sealant for perimeter moldings: Specified in Section 079200.

D. Touch-up paint: Type and color to match acoustical and grid units.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

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

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION - SUSPENSION SYSTEM

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
6. Do not attach hangers to steel deck tabs.
7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
8. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
4. Install edge trim per manufacturers requirements.

D. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

E. Fasteners: Anchors for hanger wires in a concrete deck shall be drilled-in, wedge-type expansion anchors only. Powder-actuated fasteners shall not be used except in concrete on metal decking or structural steel framing members.

F. 48 inch spacing: All hanger wires shall be spaced no more than 48 inches apart in any direction. Extra wires shall be provided near light fixtures, so that a wire supports each corner of the fixture.

G. Layout: Unless otherwise indicated in drawings, the grid system shall be centered in the room when possible, in both directions, so that the border tiles are of equal size. If the acoustical tile has a directional pattern, the tiles shall be installed in the same direction, not alternating.

H. In existing buildings, it may be necessary to lower the ceiling to an elevation below the top of the existing window head. At such locations, raised soffits shall be provided in front of the windows. Soffit area shall be fully enclosed and shall provide sufficient clearance in front of the window for painters and glaziers to maintain the window and surrounding finishes.

I. Locate system on room axis according to reflected plan.

1. The grid system shall be centered in the room when possible, in both directions, so that the border tiles are of equal size.

J. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

K. Hanger wires shall be installed as nearly vertical as possible. If an obstruction (such as ductwork) interferes with spacing, a "trapeze" shall be used. Wires shall not be supported from ductwork, conduit or piping, only the building structure. Both ends of hanger wires shall be tightly wrapped with a minimum of 3 twists.

L. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

M. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.

N. Do not eccentrically load system or induce rotation of runners.

3.4 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install units after above-ceiling work is complete.

E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

F. Cutting acoustical units:

1. Make field cut edges of same profile as factory edges.

G. Install hold-down clips on each panel to retain panels tight to grid system; comply with fire rating requirements.

3.5 TOLERANCES

A. Maximum variation from flat and level surface: 1/8 inch in 10 feet.

B. Maximum variation from plumb of grid members caused by eccentric loads: 2 degrees

3.6 CLEANING

A. exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096500 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resilient tile flooring and installation accessories.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions

2. Section 090561 - Common Work Results For Flooring Preparation: independent agency testing of concrete slabs, removal of existing floor coverings, cleaning, and preparation.

1.2 REFERENCE STANDARDS

A. ASTM E648 - Standard Test Method For Critical Radiant Flux Of Floor-Covering Systems Using A Radiant Heat Energy Source; 2014C.

B. ASTM F1066 - Standard Specification For Vinyl Composition Floor Tile; 2004 (Reapproved 2014)E1.

C. ASTM F1700 - Standard Specification For Solid Vinyl Floor Tile; 2013A.

D. NFPA 253 - Standard Method Of Test For Critical Radiant Flux Of Floor Covering Systems Using A Radiant Heat Energy Source; National Fire Protection Association; 2015.

E. 2RFCI (RWP) - Recommended Work Practices For Removal Of Resilient Floor Coverings; Resilient Floor Covering Institute; October 2011.

1.3 SUBMITTALS – NOT USED

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all materials off of the floor in an acclimatized, weather-tight space.

B. Protect roll materials from damage by storing on end.

C. Do not double stack pallets.

1.5 FIELD CONDITIONS

A. Maintain temperature in storage area between 55 degrees F and 90 degrees F.

B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 - PRODUCTS

2.1 TILE FLOORING

A. Vinyl Composition Tile (VCT): Homogeneous, with color extending throughout thickness.

1. Minimum requirements: Comply with ASTM F1066, of class corresponding to type specified.
2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
3. Size: As indicated on drawings.
4. Thickness: As indicated on drawings.
5. Pattern: As indicated on drawings.
6. Color: as indicated on drawings.
7. Manufacturers:

    a. Mowhawk group or as indicated on drawings

8. Provide extra tile to be left on site for future repairs.

    a. Minimum 10% extra per tile size, style, color.
    b. Coordinate location for storage with Owner’s site lead personnel

9. Substitutions: No substitutions will be acceptable.

B. Luxury Vinyl Tile (LVT): printed film type, with transparent or translucent wear layer.

1. Minimum requirements: Comply with ASTM F1700, of class corresponding to type specified.
2. Tile size: As indicated on drawings.
3. Wear layer thickness: As indicated on drawings.
4. Total thickness: As indicated on drawings.
5. Pattern: As indicated on drawings.
6. Color: as indicated on drawings.
7. Manufacturers:

    a. Mohawk group or as indicated on drawings

8. Provide extra tile to be left on site for future repairs.

    a. Minimum 10% extra per tile size, style, color.
    b. Coordinate location for storage with Owner’s site lead personnel

9. Substitutions: No substitutions will be acceptable.

2.2 ACCESSORIES

A. Primers, adhesives, and seam sealer: Waterproof; types recommended by flooring manufacturer.

B. Moldings, transition and edge strips: Rubber.

C. Sealer and wax: Types recommended by flooring manufacturer.

1. Provide 2 coats wax at new and existing VCT and LVT

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

B. Cementitious sub-floor surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and ph.

1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

C. Verify that concrete sub-floor surfaces are ready for resilient flooring installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:

1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours.
2. Alkalinity: ph range of 5-9.

3.2 PREPARATION

A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI (RWP).

B. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.

C. Provide cementitious self-leveling compound over entire area.

D. Prohibit traffic until filler is fully cured.

3.3 INSTALLATION

A. Starting installation constitutes acceptance of sub-floor conditions.

B. Install in accordance with manufacturer's written instructions.

C. Spread only enough adhesive to permit installation of materials before initial set.

D. Fit joints and butt seams tightly.

E. Set flooring in place, press with heavy roller to attain full adhesion.

F. Where type of floor finish, pattern, or color are different on opposite sides of door terminate flooring under centerline of door.

G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.

H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.4 TILE FLOORING

A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

3.5 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean in accordance with manufacturer's written instructions.

C. Install two coats of wax.

3.6 PROTECTION

A. Prohibit traffic on resilient flooring for 48 hours after installation.

3.7 SCHEDULE

A. Refer to Finish Schedule on the Drawings.

END OF SECTION 096500

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resilient Base.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 079200 – Joint Sealers: Sealant between bases and floor or wall surfaces.

1.2 DELIVERY, STORAGE AND HANDLING

A. Transport, handle, store, and protect products in compliance with the requirements of Section 016000.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Vinyl Base: As indicated below or as shown on the Drawings:

1. Tarkett (formerly Johnsonite), Solon, OH, (800) 899-8916. (Basis of Design)
2. Armstrong Flooring, Lancaster, PA, (888) 276-7876.
3. Roppe Rubber, Fostoria, OH (800) 537-9527.
4. Burke Flooring (Mannington) Calhoun, GA;

B. Adhesive:

1. Franklin International, Columbus, OH, (800) 877-4583.

2.2 RESILIENT BASE

A. Resilient Base: ASTM F1861, Type TV, vinyl, thermoplastic; top set Style B:

1. Height: 4 inch and 6 inch as scheduled on the Drawings.
2. Thickness: 0.125 inch thick.
3. Finish: Satin.
4. Length: Roll.
5. Color: As scheduled on Drawings.
6. Accessories: Pre-molded end stops.
7. Inside and Outside Corners: Job formed. Pre-molded corners only permitted where proper anchorage cannot be obtained.
8. Provide extra base to be left on site for future repairs.

    a. Minimum 10% extra linear feet per size, style, color
    b. Coordinate location for storage with Owner’s site lead personnel

2.3 ACCESSORIES

A. Vapor Barrier Coating: Equal to Mapei - Planiseal VS.

B. Adhesives: Adhesives used in interior locations must comply with Section 016116 – Volatile Organic Compound (VOC) Restrictions for VCT and Subfloor Adhesives. Water-resistant stabilized type as recommended by flooring manufacturer or as indicated below.

1. VCT: Armstrong adhesive #S-700 or#S-515.
2. VCT High Moisture areas: Use Armstrong adhesive #S-240 in areas that are consistently wet.
3. Wall base adhesive #S-515.

C. Trowelable Leveling and Patching Compounds: Products by TEC Inc. Equal products by Bostic, and Mapei or comparable materials recommended by flooring manufacturer for applications indicated are also acceptable.

1. Material: VersaPatch, latex modified patch and leveling compound.
2. Additive: Patch Additive861.
3. Primer: Primer.

D. Moldings, Transition and Edge Strips: Vinyl. Product as scheduled on Drawings.

E. Protective Coat: "Revive Plus SC" Neutral Cleaner and "Vectra" Floor Finish by Johnson Wax Products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Resilient Base:

1. Install base in accordance with manufacturer’s requirements using manufacturer’s approved adhesive.
2. Fit joints tight and vertical. Maintain minimum measurement of 18 inches between joints. Use premolded corner units.
3. Install base on solid backing. Bond tight to wall surfaces.
4. Scribe to fit door frames and other interruptions.
5. Remove excess adhesive from floor, wall surfaces and base.

3.2 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

END OF SECTION 096513

SECTION 096723 - RESINOUS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Epoxy resin flooring and cove base.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions

2. Section 033000 - Cast-In Place Concrete Slabs: Vapor retarder installation and concrete slab finish at resinous flooring locations.

1.2 SYSTEM DESCRIPTION

A. Epoxy Resin Floor System; Nominal 1/8 inch thick system comprised of:

1. Primer.
2. Self-leveling matrix.
3. Ceramic granules.
4. Clear resin finish.
5. Quartz silica aggregate for broadcasting

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. United States Department of Agriculture Approved: Incidental food contact.

B. Installer Qualifications:

1. Approved Applicator by resinous flooring manufacturer.

2. Minimum 15 resinous flooring applications within last 3 years similar in type and size to Work of this Contract.

3. Assign experienced mechanics from previous applications including lead mechanic.

1.4 DELIVERY, STORAGE AND HANDLING

A. Section 016000 - Product Requirements: Transport, Handle, Store, and Protect Products.

B. Store material in dry, enclosed area protected from exposure to moisture.

C. Maintain temperature of storage area between 60 and 90 degrees F.

D. Store materials for three days prior to installation in area of installation to achieve temperature stability.

1.5 PROJECT CONDITIONS

A. Environmental Requirements: Maintain ambient temperature required by manufacturer three days prior, during, and 24 hours after installation of materials.

B. Keep flooring area clear of other trades during installation and for 24 hours after flooring installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, provide resinous flooring from one of the following manufacturers:

1. Benjamin Moore, Montvale, N.J. (855) 724-6802
2. Dur-A-Flex Incorporated, East Hartford, CT (800) 253-3539.
3. Stonhard, Inc., Maple Shade, NJ (800) 257-7953.

2.2 MATERIALS

A. Epoxy Resin Floor System:

1. Dur-A-Quartz system, by Dur-A-Flex (Basis of Design)
   a. 100% Solids
   b. Dur-A-Glaze Top Coat
   c. #4 Armor Top Gloss with Grit
   d. Color: Q28-22 unless otherwise specified on drawings

2. DayChem Poxy Plus J-36

2.3 MIX

A. Use materials in prepackaged quantities. Mix in accordance with manufacturer's published instructions. Job site measurement changes not permitted.

2.4 COLORS

A. Provide colors as applicable as shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and adjacent areas where products will be installed and verify that surfaces conform to product manufacturer's requirements for substrate conditions. Do not proceed until unsatisfactory conditions have been corrected.

1. Verify that surfaces are smooth and flat with maximum variation of 1/4 inch in 10 ft., and are ready to receive work of this Section.
2. Verify concrete floors have properly cured in accordance with coating manufacturer's requirements and as specified herein.
3. Verify floor is free of substances that may impair adhesion of adhesive and finish materials. Verify that floors are dry, and exhibit negative alkalinity, carbonization or dusting.

B. Beginning of installation indicates acceptance of substrate.

3.2 PREPARATION (NEW CONCRETE SLABS)

A. Cure concrete utilizing moisture cure method as specified in Section 033000 for number of days indicated in manufacturer's printed instructions. Verify concrete floors have properly cured in accordance with coating manufacturer's requirements and as specified herein.

B. Provide concrete finish surface as specified in Section 033000.

C. Provide depression in concrete slab around floor drains for thickened resinous flooring edge at floor drain as indicated on Drawings.

D. Provide underslab vapor barrier under all areas where resinous flooring is applied as specified in Section 033000.

3.3 PREPARATION (EXISTING CONCRETE SLABS)

A. Remove existing floor finish materials as shown or noted on Drawings.

1. Removal of gummy adhesives may require the use of detergents. Detergents shall be compatible with the resinous floor system and approved by the resinous floor system manufacturer. The detergent may be the resinous floor system manufacturer's proprietary product.

B. Prepare surface of existing slabs in accordance with resinous floor system manufacturer’s recommendations.

C. Obtain and follow the resinous floor system manufacturer's published information regarding substrate preparation.

D. Acid etching as a slab preparation method will not be permitted.

3.4 INSTALLATION

A. Install in accordance with manufacturer's published instructions.

B. Prime substrate using manufacturer's penetrating primers. Allow primer drying time as required by the manufacturer.

C. Provide minimum 1/8 inch flooring thickness by broadcasting method, broadcasting aggregate in three separate applications. Applicators seeking approval for applications of fewer broadcast coats shall take a core sample from a location randomly selected to verify 1/8 inch thickness. Patch core holes. If flooring system application fails to meet 1/8 inch thickness requirement apply an additional aggregate coat.

D. Provide non-skid texture as indicated on the drawings.

3.5 CONSTRUCTION

A. Terminate epoxy resin flooring as shown on Drawings where flooring system does not abut vertical surface.

B. Install 3/4 inch radius cove base integral with floor at heights indicated in locations shown on Drawings. Hand sand base and cove to create smooth surface prior to application of final top coats. Provide bases with manufacturer's cove strip cap.

3.6 FIELD QUALITY CONTROL

A. Inspect resinous flooring installation for scheduled material, color, specified thickness, and coverage.

B. Correct deficiencies in Work which inspection indicates are not in compliance with Contract requirements.

C. Manufacturer's Representative Inspection: Provide inspection by manufacturer's technical representative for the following:

1. Concrete slab substrate preparation prior to flooring installation.
2. Initial flooring installation procedures.
3. Completion of installation.

D. Manufacturer's Representative Inspection Report: Provide report of inspection describing installation deficiencies to Contractor and Architect.

3.7 CLEANING

A. Clean resinous flooring with cleaning materials recommended by flooring manufacturer one day prior to Date of Substantial Completion.

3.8 PROTECTION

A. Prohibit traffic from floor finish for 48 hours after completion of installation.

END OF SECTION 096723

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes modular carpet tile, loose laid with edges and control grid adhered with polyester backed adhesive squares.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions

2. Section 090561 “Common Work Results for Flooring Preparation”

1.2 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Provide two boxes of carpet tiles of each color and pattern selected.

1.3 REFERENCE STANDARDS

A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

B. CRI (CIS) - Carpet Installation Standard; Carpet and Rug Institute

C. CRI 104 - Standard for Installation of Commercial Textile Floorcovering Materials; Carpet and Rug Institute

D. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.5 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 CARPET TILE

A. Manufacturer: Bentley Mills (or as indicated on the Drawings).

1. Collection: Drumline (4DMT4) or as indicated on the Drawings.
2. Color: Fight Song (#404322)

B. Pattern: Reference Plans

C. Fiber Content: 100 percent nylon.

D. Fiber Type: Antron Lumena DNA Nylon Type 6,6.

E. Pile Characteristic: tufted textured loop.

F. Total Weight: 62.0 oz/sq.yd. for finished carpet tile.

G. Primary Backing/Backcoating: Manufacturer’s standard material.

H. Secondary Backing: Manufacturer's standard material.

I. Backing System (general use): Afirma II

J. Cushion Backing System (where noted on plans): Next Step Cushion.

K. Size: As indicated on the Drawings.

L. Applied Treatments:

1. Soil-Resistance Treatment: Manufacturer's standard treatment.
2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:

    a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

M. Performance Characteristics:

1. Appearance Retention Rating: Moderate traffic, 2.5 minimum according to ASTM D7330.
2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.
3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
4. Delamination: Not less than 3.5 lbf/in. according to ASTM D3936.
5. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
6. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
7. Noise Reduction Coefficient (NRC): according to ASTM C423.
8. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
9. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) according to AATCC 16, Option E.
10. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.

2.2 CARPET TILE - ENTRYWAY

A. Manufacturer: Matworks (or as indicated on the Drawings).

1. Collection: Diamond Carpet Tile, or as indicated on the Drawings.
2. Color: Charcoal

B. Pattern: Reference Plans

C. Fiber Content: 100 percent polypropylene.

D. Pile Characteristic: needle-punched.

E. Total Weight: 50.0 oz/sq.yd. for finished carpet tile.

F. Backing System: TacFast system.

2.3 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, non-staining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Concrete Slabs:

1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform at least one test in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
    c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

B. Wood Subfloors: Verify that underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

C. Metal Subfloors: Verify that underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

D. Painted Subfloors: Perform bond test recommended in writing by adhesive manufacturer.

1. Access Flooring Systems: Verify access floor substrate is compatible with carpet tile and adhesive, if any, and underlayment surface is gaps greater than 1/8 inch and protrusions more than 1/32 inch.

3.2 PREPARATION

A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern parallel to walls and borders.

I. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes

1. Vinyl wall covering.
2. Wallpaper.
3. Owner-furnished materials

B. Related Requirements

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions

PART 2 - PRODUCTS

2.1 MATERIALS

A. Adhesive: Mildew-resistant, non-staining, strippable adhesive, for use with specific wall covering and substrate application, as recommended in writing by wall-covering manufacturer, and with a VOC content complying with Section 016116 – Volatile Organic Compound (VOC) Restrictions or less when calculated according to 40 CFR 59, subpart D (EPA method 24)

B. Fabrics and Coverings: As indicated in the Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

3.2 INSTALLATION

A. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.

B. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

END OF SECTION 097200

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SECTION 099000 - PAINTING AND COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface preparation.
2. Field application of paints, stains, and other coatings.
3. Scope: Finish all interior and exterior surfaces exposed to view, unless fully factory-finished or unless otherwise indicated.

1.2 SCHEDULE – SURFACES TO BE FINISHED (Where indicated in the Drawings)

A. Interior Surfaces to be painted:

1. All walls scheduled for paint.
2. Interior concrete wall panels scheduled to be painted.
3. All hollow metal doors and frames.
4. Structural steel columns and structural steel braces shall be painted safety yellow up to 12' AFF and white from 12' AFF to underside of roof or mezzanine structure on columns with fire extinguishers, paint 24" long safety red band, all 4 sides of column, 20' AFF or as required by code. Paint entire column safety red where fire hose connections are located.
5. Bollards.
6. Ladders, safety cages.
7. Stairs and railings.
8. Guardrails.
9. Dock edge angles.
10. Sprinkler risers up to the turn out at ceiling level.
11. Exposed ductwork where indicated on Drawings.
12. Exposed conduit and piping in finished spaces.

B. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

C. Exterior Surfaces to be painted (Where indicated in the Drawings):

1. All hollow metal doors and frames.
2. All bollards.
3. Dock edge angles.
4. All exposed piping.
5. Gas piping on roof.
6. Downspout guards.
7. Loadout canopy framing and deck.
8. All other exposed metal except prefinished items.

D. Do Not Paint or Finish the Following Items:

1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
2. Items indicated to receive other finishes.
3. Items indicated to remain unfinished.
4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.

5. Floors, unless specifically so indicated.
6. Glass.
7. Concealed pipes, ducts, and conduits, unless specifically so indicated.
8. Stainless steel items.
9. Structural steel roof framing, joists, bridging and metal roof deck (unless noted otherwise).
10. Piping, conduit, and ductwork (unless specifically noted).
11. Prefinished wood doors.

1.3 RELATED REQUIREMENTS

A. Section 016116 – Volatile Organic Compound (VOC) Restrictions

B. Section 051200 – Structural Steel Framing: Shop-primed items.

C. Section 052100 – Steel Joist Framing: Shop-primed items.

D. Section 053100 – Steel Decking: Shop-primed items.

E. Section 055000 - Metal Fabrications: Shop-primed items.

F. Section 055119 - Metal Grating Stairs: Shop-primed items.

G. Section 055213 – Metal Pipe and Tube Railing

1.4 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency

B. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials

1.5 SUBMITTALS – NOT USED

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience.

B. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

C. All paint materials, preparation and workmanship shall conform to the requirements of the latest edition of the architectural painting specification manual by the Master Painters Institute.

D. Provide lead free prime and finish coatings. All top coatings shall be mold and mildew resistant.

1.7 DELIVERY, STORAGE, ANDHANDLING

A. Deliver materials to the project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Product name or tile of material
2. Product description (generic classification or binder type).

3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions
6. Application instructions
7. Color name and number
8. VOC content

B. Paint Materials Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 degrees F (7 degrees C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing and application.

1.8 .PROJECT CONDITIONS

A. Environmental Requirements:

1. Comply with manufacturer's recommendations as to environmental conditions under which materials may be applied.
2. Apply no materials in spaces where dust is being generated.

B. Protections: Cover finished work of other trades and surfaces not being painted concurrently and prefinished items. "Wet Paint" signs shall be posted in all "Wet Paint" areas.

C. Safety Precautions:

1. Provide temporary fire protection equipment in materials' storage area.
2. Prohibit smoking in storage area.

D. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

E. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Materials selected for coating systems for each type surface shall be the product of a single manufacturer. Except as otherwise specified, materials shall be the products of the following manufacturers:

1. Sherwin Williams (Basis of Design)
2. Benjamin Moore
3. PPG.

B. Exterior concrete textured coatings over concrete walls shall be 100% acrylic with no modifiers, 16-20 mils total dry film thickness, with manufacturer’s 5 year material warranty. System to include primer and textured finish coat.

2.2 PAINTS AND COATINGS -GENERAL

A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.

1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
2. Supply each coating material in quantity required to complete entire project's work from a single production run.
3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.

B. Volatile Organic Compound (VOC) Content:

1. Provide coatings that comply with the most stringent requirements specified in Section 016116 Volatile Organic Compound (VOC) Restrictions and the following:

a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
b. Architectural coatings VOC limits of State in which the project is located.
c. Low VOC Products: Provide products compliant with Green Seal GS-11, Paints, and tested in accordance with ASTM D5116, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials / Products and with ASTM D6670, Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials / Products.

2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

3. Product: TNEMEC Low VOC ‘hydroflon’ series 701 or equal by PPG.

C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

D. Colors: As indicated on the Drawings.

1. When approved alternate vendor products are used, colors are to match those of the vendor’s colors indicated on drawings.

2.3 SCHEDULE OF FINISHES (SHERWIN WILLIAMS)

A. General: Unless noted otherwise, all building and site components are to receive finishes as noted below.

B. Interior Paint and Stain Schedule:

1. Interior Gypsum Wallboard at all areas unless otherwise noted (painted):
a. Latex Primer Sealer (1) coat: Sherwin Williams: B28W200 Prep-Rite 200 Latex Primer
b. Latex Acrylic Enamel, Eggshell, (2) coats: Sherwin Williams: B20W2251 ProMar 200 Acrylic Latex Eggshell Enamel

c. Gypsum Wall Board surfaces in restrooms and wet walls shall receive one coat of latex enamel over one coat of PVA sealer

2. Gypsum Board Ceiling – High Gloss Epoxy Paint Finish

   a. (1) coat Benjamin Moore; fresh start enamel underbody primer (217): applied at a dry film thickness of not less than 1.4 to 2.0 mils. (spot prime required only on re-paint projects)
   b. (2) coats Benjamin Moore; Eco-Spec interior paint - Semi-gloss (512): as noted in finish schedule, applied at a dry film thickness of not less than 1.5 to 2.0 mils.
   c. Conventional spray, HVLP or airless spray. Touch-ups shall be done with conventional spray or airless equipment or brush or roller.

3. Electrical Room Mounting Boards, Fire Retardant Latex, 2 Coat: (Low VOC)

   a. One to two coats as required for full coverage.

4. Interior Wood (sealed):

   a. 2 coats Minwax Water Based Oil-Modified Polyurethane.

5. Interior Wood (stained):

   a. 1 coat stain: PPG Olympic 44500 Interior Low VOC Oil Based Wood Stain
   b. 1 coats polyurethane satin: PPG Olympic 42786 Interior Waterbased Polyurethane Satin

6. Interior Ferrous and Galvanized Metals, Primed, Acrylic Enamel, 2 Coat: (Low VOC):

   a. Primer, (1) coat: Sherwin Williams: B66-310 Series Pro Industrial ProCryl Universal
   b. Acrylic Enamel, Semi-gloss, (2) coats: Sherwin Williams: B66-600 Pro Industrial Acrylic Semi-Gloss

7. Interior Concrete Walls (Sealed)

   a. Prime (Bare): (1) coat Seal-Krete Clean-n-Etch. If etching with muriatic acid, surface must be neutralized before proceeding.
   b. Prime (painted): Freshly painted surfaces must be cured a minimum of 72 hours. Painted surfaces must not be peeling or blistering and cleaned with a water and trisodium phosphate (TSP) solution. Rinse well and allow to dry.
   c. Finish: (1) coat Seal-Krete Clear-Seal - Satin.
   d. Locations: As indicated on the Drawings.

8. Interior Concrete Walls, Opaque, Latex, 2 Coat: (Low VOC)

   a. Latex primer sealer: (1) coat Sherwin Williams: B28W200 Prep-Rite 200 Latex Wall Primer.
   b. Flat: One coat of latex: Sherwin Williams: B30-3200 Series ProMar 200 XP Latex Flat Wall Paint

9. Interior Concrete Opaque, Waterborne Epoxy, 2 Coat: (Low VOC)

   a. Semi-gloss: (2) coats: PPG: 16-510 Pitt-Glaze WB1Pre-Catalyzed Acrylic Semi Gloss Epoxy

10. Interior Masonry (CMU) with Block Filler (painted):

    a. Block filler, (1) coat: Sherwin Williams: S-W Loxon Acrylic Masonry Primer, A24W8300
    b. Latex Enamel, (2) coats: Sherwin Williams: S-W ProGreen 200 Interior Latex Semi-Gloss, B31-600 Series

11. Exposed Galvanized Ductwork; Shop Primed Metal Deck, Structural Steel Roof Framing, Joists, Bridging: Dryfall Waterborne Acrylic:

    a. (1) coat ProCryl Universal Primer over steel or 1 coat PrepRite Wall and Wood Primer over wood
    b. (2) coats PRO Industrial Waterborne Acrylic Dryfall Semi-Gloss, B42W83; or (2) coats Pro Industrial Waterborne Acrylic Dryfall Eg-Shel, B42W00082
    c. Conventional spray, HVLP or airless spray. Touch-ups shall be done with conventional spray or airless equipment or brush or roller.

C. Exterior Paint and Stain Schedule:

1. Exterior Ferrous Metal (painted):

    a. 1 coat Pro Industrial Pro-Cryl Universal Primer B66-310 Series
    b. 2 coats Pro Industrial Acrylic #B66 Series

2. Shop Primed Metal Deck, Shop Primed Structural Steel Roof Framing, Joists, Bridging:

    a. (2) coats Pro Industrial Acrylic Semi-Gloss, B66-600 Series; or (2) coats Pro Industrial Acrylic Eg-Shel, B66-600 Series
    b. Conventional spray, HVLP or airless spray. Touch-ups shall be done with conventional spray or airless equipment or brush or roller.

3. EIFS (painted):

    a. 1 coat Loxon Concrete & Masonry Primer LX02W0050 Series
    b. 2 coats A-100 Exterior Latex Flat, A6 Series

4. Exterior Stucco (painted):

    a. If pH level is over 6, but under 13, prime with Loxon Concrete & Masonry Primer LX02W0050 first
    b. 2 coats A-100 Exterior Latex Flat, A6 Series

5. Exterior Top of Stucco Walls, Top and Back of Masonry Parapets (elastomeric):

    a. 1 coat Sherwin-Williams ConFlex XL High Build Coating elastomeric sealant (wall to be dry before application)

6. Exterior Masonry with Block Filler (painted):

    a. 1 coat PrepRite Block Filler B25W25
    b. 2 coats A-100 Exterior Latex Flat, A6 Series

7. Exterior Masonry without Block Filler:

    a. 1 coat Loxon Acrylic Primer LX02W0050
    b. 2 coats A-100 Exterior Latex Flat, A6 Series

8. Exterior Concrete (texture finish)

    a. 1 coat Loxon Acrylic Primer LX02W0050
    b. 2 coats Ulta Crete Textured Masonry Topcoat (medium texture) CF17W0811 Series

9. Exterior Wood Stain (semi-transparent):

    a. 2 coats WoodScapes Exterior Semi-Transparent Stain, A15T5

10. Exterior Wood Stain (opaque):

    a. Exterior Oil-Based Wood Primer, Y24W8020
    b. 2 coats WoodScapes Exterior Solid Color Acrylic Latex, A15 series

11. Exterior Wood (painted):

    a. 1 coat Exterior Latex Wood Primer, B42W8041
    b. 2 coats A-100 Exterior Latex Flat, A6 Series

2.2 MATERIALS NOT SPECIFIED

A. Painting Subcontractor shall designate type of paint to be used on each portion of the work not itemized above. Such material shall meet the Architect's approval.

B. Paint finish (gloss. flat, etc.) shall be verified with the Architect or Tenant's representative prior to painting on the job.

C. All graphic lines to be applied using "easy-mask" masking tape.

D. All cut lines to be true without overlaps or voids.

E. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

2.3 ACCESSORY MATERIALS

A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.

B. Patching Material: Latex filler.

C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application. Application of primers, paints, stains or finishes represents acceptance by the contractor that the surfaces were properly prepared and suitable forapplication.

C. Test shop-applied primer for compatibility with subsequent cover materials.

D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:

1. Gypsum Wallboard: 12 percent.
2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
3. Interior Wood: 15 percent, measured in accordance with ASTMD4442.
4. Concrete Floors and Traffic Surfaces: 8 percent.

3.2 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to coating application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the projectconditions.

C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

D. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.

E. Seal surfaces that might cause bleed through or staining of topcoat.

F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

G. Concrete and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri- sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow todry.

H. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

I. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

J. Uncorroded Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

K. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.

L. Interior Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

M. Interior Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.

N. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.3 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

C. Apply each coat to uniform appearance.

D. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

E. Apply paint, enamel, stain and varnish with suitable brushes, rollers or spraying equipment.

1. Rate of application shall not exceed that as recommended by paint manufacturer for the surface involved.
2. Keep brushes and rollers and spraying equipment clean, dry, free from contaminates and suitable for the finish required.
3. Apply stain by brush.

F. Finish coats shall be smooth, free of brush marks, streaks, laps or pile up of paints and skipped or missed areas.

G. Leave all parts of moldings and ornaments clean and true to details with no undue amount of paint in corners and depressions.

H. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.

I. Change colors at corner of stop where colors differ between adjoining spaces or rooms and where door frames match wall colors.

J. Where portion of finish or drywall partition is damaged or unacceptable, refinish entire surface of partition.

K. Back-prime exterior carpentry and millwork with material specified for prime coat, without runs on face. Finish cut edges just prior to installation.

L. Finish all edges of exterior doors same as faces.

M. The number of coats specified are minimum. The Contractor shall provide at no additional cost to the Owner, as many coats as necessary for color coverage conformity and uniform appearance.

1. At all exterior ferrous metal items, minimum 2.5 dry mils, 4.0 wet mils. Air spray application.

N. Sand wood and metal surfaces lightly between coats to achieve required finish.

O. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.4 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.5 PROTECTION

A. Protect finished coatings until completion of project.

B. Touch up and restore finish where damaged. Remove spilled, splashed or splattered paint from all surfaces.

C. Do not mar surface finish of item being cleaned.

END OF SECTION 099000

SECTION 101101 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Tackboards. (TB-X)

1.2 REFERENCE STANDARDS

A. ANSI A135.4 - American National Standard For Basic Hardboard; 2012.

B. ANSI A208.1 - American National Standard For Particleboard; 2009.

C. ASTM A424/A424M - Standard Specification For Steel, Sheet, For Porcelain Enameling; 2009a.

D. ASTM E84 - Standard Test Method For Surface Burning Characteristics Of Building Materials; 2015a.

E. ASTM F793 - Standard Classification Of Wall Covering By Use Characteristics; 2010a.

F. FS L-P-1040 - Plastic Sheets And Strips (Polyvinyl Fluoride); Federal Specifications And Standards; Revision B, 1977.

1.3 QUALITY ASSURANCE

A. Manufacturer qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Visual display boards (tackboards)

1. Claridge Products And Equipment, Inc: www.claridgeproducts.com
2. Platinum Visual Systems; a division of ABC School Equipment.

2.2 VISUAL DISPLAY BOARDS

A. Tackboards: Composition cork. (TB-X);

1. Cork thickness: 1/8 inch.
2. Color: As selected from manufacturer's full range.
3. Backing: Hardboard, 1/4-inch-thick, laminated to tack surface.
4. Surface burning characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
5. Standard tack board height: 48 inches.; width as indicated on drawings.
6. Frame: Extruded aluminum, with concealed fasteners.
7. Frame profile: Manufacturer's standard
8. Frame finish: Anodized, natural.

2.3 MATERIALS - VISUAL DISPLAY BOARDS

A. Vinyl coated fabric: ASTM F793 category VI; clear top overcoat of polyvinyl fluoride in accordance with FS L-P-1040 type 1, grade B, class 2, 0.0005 inch thick.

B. Hardboard for cores: ANSI A135.4, class 1 - tempered, S2S (smooth two sides).

C. Particleboard: ANSI A208.1; wood chips, set with waterproof resin binder, sanded faces.

D. Foil backing: aluminum foil sheet, 0.005 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.2 INSTALLATION

A. Install boards in accordance with manufacturer's instructions.

B. Secure units level and plumb.

3.3 CLEANING

A. Clean board surfaces in accordance with manufacturer's instructions.

END OF SECTION 101101

SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes room, door, and informational signage.

B. Related Requirements:

1. Section 012100 - Allowances: Signage allowance for tenant building identification, site monument signage, and site trafficsignage.
2. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.2 REFERENCE STANDARDS

A. All work shall conform to all ordinances and regulations of the City, County, State and/or other authorities having jurisdiction.

B. Reference locally adopted codes and ordinances for additional requirements.

PART 2 - PRODUCTS

2.1 SIGNAGE APPLICATIONS

A. Accessibility compliance: Signs are required to comply with ADA standards and ICC A117.1 and applicable codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.

B. Room and door signs: Provide a sign for restrooms, storage and utility rooms

1. Sign type: Flat signs with applied character panel media as specified.
2. Provide “tactile” signage, with letters raise minimum 1/32 inch and grade II braille.
3. Character height: 1 1/2 inch
4. Sign height: 4 inch, unless otherwise indicated
5. Miscellaneous rooms: Identify with room name.
6. Rest rooms: Identify with pictograms, the names “MEN” and “WOMEN”, and braille.

C. Emergency evacuation maps:

1. Allow for one map to be located at the main entrance/exit.
2. Map content to be provided by tenant/architect.

D. Other dimensional letter signs: Wall-mounted

1. Exterior: Allow for numbers and/or letters, 6 inches
2. High, vinyl. Provide contrasting color of white or black. Letter placement per the architect's drawings or as directed by fire marshal.

2.2 SIGN TYPES

A. Flat signs: Signage media without frame

1. Edges: Beveled
2. Corners: Radiused

B. Vinyl Printed Adhesive Signage:
   1. Vendor: FastSigns
      a. Alternate vendor: Landmark Signs
         1) www.lmasigns.com (Jim Carroll – 612-916-1102)
   2. Type: Vinyl – adhesive backed
   3. Color: as indicated on Construction Drawings
   4. Text: as indicated on Construction Drawings

C. Wall mounting of one-sided signs: concealed screws

D. Color and font: Unless otherwise indicated

   1. Character font: Helvetica, Arial, or other Sans Serif font
   2. Character case: Upper case only
   3. Background color: As scheduled
   4. Character color: Contrasting color

E. Products

   1. Tactile Room ID:

      a. Vendor: www.justbraillesigns.com
      b. Alternate vendor: Landmark Signs
         1) www.lmasigns.com (Jim Carroll – 612-916-1102)
      c. Type: Restroom ADA braille sign (economy sign series)
      d. Size: 6" x 9"
      e. Text: Per sign type
      f. Color: Charcoal gray

   2. Tenant ID Signage:

      a. Vendor: www.justbraillesigns.com
      b. Alternate vendor: Landmark Signs
         1) www.lmasigns.com (Jim Carroll – 612-916-1102)
      c. Type: Custom ADA room ID sign (economy sign series)
      d. Size: 3" x 10"
      e. Text: Font type as per Tenant requirements.
      f. Color: Charcoal gray

   3. Tactile Exit Sign (wall):

      a. Vendor: www.justbraillesigns.com
      b. Alternate vendor: Landmark Signs
         1) www.lmasigns.com (Jim Carroll – 612-916-1102)
      c. Type: Exit sign (economy sign series)
      d. Size: 6" x 6"
      e. Text: Per sign type
      f. Color: Charcoal gray

4. Tactile Exit Sign (mullion):

    a. Vendor: www.compliancesigns.com
    b. Alternate vendor: Landmark Signs
        1) www.lmasigns.com (Jim Carroll – 612-916-1102)
    c. Type: ADA exit white on gray (RSME-19471 - white on charcoal gray, enter / exit)
    d. Size: 2" x 8"
    e. Text: Per sign type
    f. Color: Charcoal gray

5. Tactile Exit Route Sign:

    a. Vendor: www.justbraillesigns.com
    b. Alternate vendor: Landmark Signs
        1) www.lmasigns.com (Jim Carroll – 612-916-1102)
    c. Type: Exit Route Sign (economy sign series)
    d. Size: 6" x 6"
    e. Text: Per sign type
    f. Color: Charcoal gray

6. Fire Extinguisher Sign:

    a. Vendor: www.justbraillesigns.com
    b. Alternate vendor: Landmark Signs
        1) www.lmasigns.com (Jim Carroll – 612-916-1102)
    c. Type: Fire extinguisher ADA braille pictogram sign (economy sign series)
    d. Size: 6" x 9"
    e. Text: Per sign type
    f. Color: Charcoal gray (confirm owner color acceptance w/ local fire marshal - alternate color is red)

2.3 ACCESSORIES

A. Concealed screws: stainless steel, galvanized steel, chrome plated, or other non-corroding metal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install neatly, with horizontal edges level and per code/ADA requirements.

C. Locate signs where indicated:

1. If no location is indicated obtain Owner's instructions.

D. Protect from damage until Substantial Completion; repair or replace damage items.

END OF SECTION 101400

SECTION 102113.17 - PHENOLIC-CORE TOILET COMPARTMENTS

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. Phenolic-core toilet compartments configured as toilet enclosures and urinal screens.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for blocking support of compartments and urinal screens.
2. Section 102800 "Toilet Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

1.3 ACTION SUBMITTALS – NOT USED

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.5 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. Door Hinges: One hinge(s) with associated fasteners.
2. Latch and Keeper: One latch and keeper with associated fasteners.
3. Door Bumper: One door bumper with associated fasteners.
4. Door Pull: One door pull with associated fasteners.
5. Fasteners: Ten fasteners of each size and type.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 75 or less.
2. Smoke-Developed Index: 450 or less.

B. Regulatory Requirements: Comply with applicable provisions in ICC A117.1 for toilet compartments designated as accessible.

2.2 PHENOLIC-CORE TOILET COMPARMENTS

A. Bobrick – DuraLine Series – Compact Laminate (CL Phenolic) 1082

1. Overhead braced

B. MetPar – Corinthian (FP-500)

1. Overhead braced

C. Toilet-Enclosure Style: Overhead braced.

D. Urinal-Screen Style: Wall hung.

E. Door, Panel, Screen, and Pilaster Construction: Solid phenolic-core panel material with melamine facing on both sides fused to substrate during panel manufacture (not separately laminated), and with eased and polished edges. Provide minimum 3/4-inch thick doors and pilasters and minimum 1/2-inch thick panels.

F. Pilaster Shoes: Formed from stainless steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.

G. Brackets (Fittings):

1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

H. Phenolic-Panel Finish:

1. Facing Sheet Finish: One color and pattern in each room.
2. Color and Pattern:

a. Bobrick – Brushed Aluminum 0328 FH
b. MetPar – Fog 961

3. Edge Color: Manufacturer's standard.

2.3 HARDWARE AND ACCESSORIES

A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.

1. Hinges: Manufacturer's minimum 0.062-inch thick stainless steel continuous, cam type that swings to a closed or partially closed position, allowing emergency access by lifting door. Mount with through-bolts.
2. Latch and Keeper: Manufacturer's heavy-duty surface-mounted cast-stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.
3. Coat Hook: Manufacturer's heavy-duty combination cast-stainless steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
4. Door Bumper: Manufacturer's heavy-duty rubber-tipped cast-stainless steel bumper at out-swinging doors. Mount with through-bolts.
5. Door Pull: Manufacturer's heavy-duty cast-stainless steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 MATERIALS

A. Aluminum Castings: ASTM B26/B26M.

B. Aluminum Extrusions: ASTM B221.

C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

D. Stainless Steel Castings: ASTM A743/A743M.

E. Zamac: ASTM B86, commercial zinc-alloy die castings.

2.5 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

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

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

a. Pilasters and Panels: 1/2 inch.
b. Panels and Walls: 1 inch.

2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.

a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.17

SECTION 102601 - WALL END PROTECTORS AND CORNER GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Corner guards.

B. Related Requirements:

1. Section 016116 – Volatile Organic Compound (VOC) Restrictions
2. Section 092116 - Gypsum Board Assemblies

1.2 REFERENCE STANDARDS

A. ICC A117.1 - Accessible And Usable Buildings And Facilities International Code Council; 2009 (ANSI).

B. ASTM E84 - Standard Test Method For Surface Burning Characteristics Of Building Materials; 2015A.

C. ASTM E119 - Standard Test Methods For Fire Tests Of Building Construction And Materials; 2014.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Wall and corner guards:

1. Basis of design: Inpro Corporation; product type 304, surface mounted corner guard: www.inprocorp.com.

a. Arden Architectural Specialties, Inc: www.ardenarch.com
b. Construction Specialties, Inc: www.c-sgroup.com
c. Substitutions: None permitted

2.2 COMPONENTS

A. Corner Guards - surface mounted: Extruded one-piece unit without splices, installed with adhesive.

1. Material: Type 304 stainless steel, no. 4 finish
2. Thickness: 18 gauge, 0.05 inch
3. Width of legs: 2 inches
4. Length: 48 inches
5. Styles: Provide 90 degree corners

B. Wall End Protectors - surface mounted: Extruded one-piece unit without splices, installed with adhesive

1. Material: Type 304 stainless steel, no. 4 finish
2. Thickness: 18 gauge, 0.05 inch
3. Width of legs: 2 inches
4. Length: 48 inches
5. Styles: Provide channel shape to fit over wall end as indicated on plans (90 degree corners)

2.3 FABRICATION

A. Fabricate components with tight joints, corners and seams.

B. Form end trim closure by capping and finishing smooth.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.

B. Verify that field measurements are as indicated on drawings.

3.2 INSTALLATION

A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.

3.3 TOLERANCES

A. Maximum variation from required height: 1/4 inch.

B. Maximum variation from level or plane for visible length: 1/4 inch.

END OF SECTION 102601

SECTION 102650 - EQUIPMENT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment Protection
2. Pedestrian Protection
3. Traffic Deterrent Rail System

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for steel angle corner guards and pipe guards.

1.2 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.2 PRODUCTS

A. Equipment Guard Rails:

1. Manufacturers:
   a. Heartland Engineered Products, www.heartlandsteel.com
      1) Model C2 – 2 Rail System
   b. Rhino Rails, www.rhinorails.com , Phone: 864-571-1880
2. Height: 42” – Double Rail
3. Length: As indicated in the Drawings
4. Color: Safety Yellow
5. Locations: Where indicated on the Drawings.

B. Traffic Deterrent Rail System:

1. Manufacturer: Boplan (basis of design)
   a. Model Number: TB260 Double Plus
   b. Length: as indicated in drawings,
      1) 4’, 6’ and 8’ (centerline to centerline)
   c. Contact: Mike Radgowski, Regional Account Manager, Phone: (678) 770-0646, email: m.radgowski@boplan.com
   d. Color: OSHA Safety Yellow
   e. Locations: Where indicated on plans

2. Manufacturer: A-Safe, www.asafe.com ,
   a. Model Number: iFlex Double Traffic Guardrail+
   b. Length: as indicated in the drawings,
      1) Available lengths 24”, 32”, 40”, 48”, 56”, 64”, 72”, 80”, 88”
   c. Contact: Jon-Michael Craze – Senior Account Manager, Phone: (570) 502-7848, email: jonmichael.craze@asafe.us
   d. Color: OSHA Safety Yellow
   e. Locations: Where indicated on plans.

2.3 ANCHORAGE

A. Fasteners: As recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation Quality: Install devices according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

B. Mounting Heights: Install protection in locations as indicated on Drawings.

C. Accessories: Provide baseplates, caps, mounting hardware, floor anchors, trim, joint moldings, and other accessories required for a complete installation.

END OF SECTION 102650

SECTION 102800 - TOILET ACCESSORIES

PART 1 - GENERAL:

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.

B. Related Requirements:

1. Section 061000 - Rough Carpentry: Concealed supports for accessories, including in wall framing and plates.
2. Section 088000 - Glazing: Unframed mirrors.
3. Section 102113.17 – Phenolic-Core Toilet Compartments.

1.2 REFERENCES

A. ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium

1.3 COORDINATION

A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. As indicated on the Drawings.

2.2 MATERIALS

A. Accessories - general: shop assembled, free of dents and scratches, packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.

B. Keys: provide two (2) keys for each accessory to owner/tenant.

C. Stainless steel sheet: ASTM A666, type 304

D. Stainless steel tubing: ASTM A269/A69M, type 304 or 316.

E. Mirror glass: annealed float glass, ASTM C1036 type I, class 1, quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

2.3 FINISHES

A. Stainless steel: no. 4 brushed finish unless otherwise noted.

2.4 TOILET ROOM ACCESSORIES

A. Soap Dispenser: Touch free soap dispensing mechanism.

1. Basis of design:

a. Manufacturer: Grainger
b. Model: 1PKP8.

B. Clothes hook: Wall mounted coat hook; bright polished stainless steel

1. Basis of design:

a. Manufacturer: Bobrick
b. Model: B-212.

C. Toilet seat cover dispenser: Satin finish dispensing mechanism.

1. Basis of design:

a. Manufacturer: Grainger
b. Model: 22LC68.

D. Surface mounted sanitary napkin disposal.

1. Basis of design:

a. Manufacturer: Grainger
b. Model: 1ECK9.

E. Semi Recessed Sanitary Product Dispenser.

1. Basis of design:

a. Manufacturer: Bobrick
b. Model: B-47064-C.

F. Grab bars: stainless steel, non-slip grasping surface finish

1. Basis of design:

a. Manufacturer: Bobrick
b. Model: B-6806.99X48.
c. Style: 1 1/2 inch (48 mm) outside diameter stainless steel grab bars with snap flange.

G. Grab bars: stainless steel, non-slip grasping surface finish

1. Basis of design:

a. Manufacturer: Bobrick

b. Model: B-6806.99X36.
c. Style: 1 1/2 inch (8 mm) outside diameter stainless steel grab bars with snap flange.

H. Mirror

1. Basis of design:

a. Manufacturer: Bobrick
b. Model: B-290.

I. Paper towel dispenser

1. Basis of design:

a. Manufacturer: Grainger
b. Model: Enmotion 2XLH5.

J. Accessible Vertical Grab Bar

1. Basis of design:

a. Manufacturer: Bobrick
b. Model: B-6806.99X18.
c. Style: 1 1/2 inch (8 mm) outside diameter stainless steel grab bars with snap flange.

K. Toilet paper dispenser: Twin jumbo-roll.

1. Basis of design:

a. Manufacturer: Grainger
b. Model: 1FC63.

L. Stainless Steel Shelf; Surface Mounted

1. Basis of design:

a. Manufacturer: Bobrick
Model: B-295 X 24

M. Trash Receptacle

1. Basis of design:

a. Manufacturer: Grainger
b. Model: 1971258.

N. Sanitizer Dispenser

1. Basis of design:

a. Manufacturer: Grainger
b. Model: 1PKP9.

O. Sharps Container

1. Basis of design:

a. Manufacturer: Stericycle
b. Model: SKU MBBRKTLC

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on the drawings.

B. Install plumb and level, securely and rigidly anchored to substrate.

C. Mounting heights: As required by accessibility regulations, unless otherwise indicated.

END OF SECTION 102800

SECTION 104400 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes fire extinguishers, cabinets, mounting brackets and related accessories.

1.2 REFERENCE STANDARDS

A. NFPA 10 – Standard for Portable Fire Extinguishers

B. UL (DIR) – Online Certifications Directory; current listings database at www.ul.com

1.3 QUALITY ASSURANCE

A. Single source responsibility: Obtain extinguishers and cabinets from one source from a single manufacturer.

B. NFPA compliance: Fabricate and label fire extinguishers to comply with the requirements listed in the codes, standards, and regulations document within these standards

C. Fire extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 FIRE EXTINGUISHERS

A. Provide fire extinguishers for locations indicated on Drawings, in colors and finishes selected by Architect / Engineer from manufacturer's standard, that comply with authorities having jurisdiction.

B. Provide fire extinguisher types as follows:

1. Multi-purpose dry chemical type: UL rated 4A-60BC, 10 lb. Nominal capacity, in enameled steel container, for class A, B, and C fires (use requires special approval by owner).

    a. Amerex Model B456
    b. Ansul Sentry Model AA10s
    c. Buckeye Model 10 Tall ABC
    d. Quantity: Provide (1) wall mounted extinguisher.

2.3 MOUNTING BRACKETS

A. Brackets: Designed to prevent accidentally dislodging extinguisher, of sizes required for type and capacity of extinguisher indicated.

1. Provide manufacturer's standard metal brackets for extinguishers not located in cabinets.

2.4 FIRE EXTINGUISHER CABINETS

A. Cabinets and accessories: Basis of design: Larsen's Manufacturing Co; Architectural series - use fire rated model in all fire rated walls.

1. Door: Solid
2. Handle: Recessed
3. Lettering: Red vertical die cut “FIRE EXTINGUISHER”
4. Finish: Clear anodized aluminum
5. Fully Recessed Model: AL2409-R2 (fire rated walls FS-AL2409-R2)
6. Semi Recessed Model: AL2409-R4 (fire rated walls FS-AL2409-R4)
7. Quantity: Provide equipment in quantities as specified on the drawings and as required by local fire marshal
8. Location: See floor plan

B. Provide fire extinguisher cabinets where indicated and from the same manufacturer as the extinguishers. Provide sizes required for housing specified fire extinguishers, and as follows:

C. Construction: Manufacturer's standard steel box, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind smooth. Miter and weld perimeter door frames.

D. Fire rated cabinets: UL listed with UL listing mark with rating of wall where it is installed.

E. Trim style: Fabricate trim in one piece with corners mitered, welded, and ground smooth.

1. Trimless with hidden flange of same metal and finish as box (tub) that overlaps surrounding wall finish and is concealed from view by an overlapping door.

F. Door material and construction: Manufacturer's standard door construction, of material indicated, coordinated with cabinet types and trim styles selected.

1. Door shall include lettering.

G. Identify fire extinguisher in cabinet with fire extinguisher lettering applied to door vertically. Provide lettering to comply with authorities having jurisdiction for letter style, red in color, size, spacing, and location.

H. Identify bracket mounted extinguishers with fire extinguisher in red letter decals applied to wall surface. Use letter size, style, and location as selected by AE.

I. Door style: Manufacturer's standard design.

1. Solid panel: Full flush opaque panel of material indicated.

J. Door hardware:

1. Provide manufacturer's standard door operating hardware of proper type for cabinet type, trim style, and door material and style indicated. Provide concealed or continuous type hinge permitting door to open 180 deg.

2.5 FINISHES FOR FIRE EXTINGUISHER CABINETS, GENERAL

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary protective covering prior to shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Install in locations and at mounting heights indicated or, if not indicated, at heights to comply with applicable regulations of governing authorities.

1. Prepare recesses in walls for fire extinguisher cabinets as required by type and size of cabinet and style of trim and to comply with manufacturer's instructions.
2. Fasten mounting brackets and fire extinguisher cabinets to structure, square and plumb.

END OF SECTION 104400

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SECTION 107313 - AWNINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fixed awnings.

1.2 SUBMITTALS – NOT USED

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, mounting heights, and attachment details.

a. Plans are to be signed and sealed by a licensed civil or structural engineer when/as required by the Authority Having Jurisdiction

2. Detail fabrication and assembly of awnings including seam layout and spacing.
3. Graphics (when required): Show text message, font, character sizes, and other graphic forms; character, word, and line spacing; margin widths; position of copy; and other information related to graphic design.

C. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 WARRANTY

A. Special Warranty: Manufacturer and fabricator agree to repair or replace components of awnings that fail in materials or workmanship within specified warranty period.

1. Awning Frame Warranty Period: One (1) year from date of Substantial Completion.
2. Fabric Warranty Period: Three (3) years from date of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery and Storage: Deliver material to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer. Store materials in accordance with manufacturer’s instructions, in a clean, dry, well ventilated area, above ground on blocking and do not allow materials to become wet, stained or dirty.

B. Handling: Handle materials so as to protect materials, coatings and finishes during transportation and installation to prevent damage or staining. Handle fabric in accordance with manufacturer’s instructions. Use care in handling of fabric to avoid damage to fabric material and coating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Lawrence Fabric & Metal Structures – (Basis of Design)

    a. Contact: Tim Koehler, (636) 861-0100, timkoehler@lawrencefabric.com

2. Canvas Craft – canvascraftinc.com
3. Awntech – awntech.com
4. Sunair Awnings – sunairawnings.com

2.2 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

B. Fire-Test-Response Characteristics: Provide awning fabrics with the fire-test-response characteristics indicated, as determined by testing identical products according to test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Resistance Ratings: Passes NFPA 701

    a. For California projects: California Code of Regulations, Title 19.

2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency for Flame-Spread Index of 25 or less.
3. Permanently attach label to each awning fabric indicating whether fabric is inherently and permanently flame resistant or is treated with flame-retardant chemicals, and whether it requires retreatment after designated time period or cleaning.

2.3 FABRIC

A. Manufacturer for Awning Fabric: Sunbrella Mayfield

1. Fiber Content: manufacturer’s stock fabric suitable for application; or as noted on drawings.
2. Color: Azure – SKU: 6069-0000.
3. Mildew Resistance: Showing no growth when tested according to ASTM G21.
4. Applied Treatment: Stain resistant treatment.

B. Seam Thread (where seams are sewn): UV-light, mildew, and rot resistant.

2.4 AWNING FRAME AND ACCESSORY MATERIALS

A. Steel:

1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
2. Steel Tubing: ASTM A500/A500M.

3. Galvanized Steel Tubing: ASTM A787/A787M.
4. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40).

B. Aluminum: Alloy and temper recommended by awning manufacturer for type of use and finish indicated and with not less than the strength and durability properties of alloy and temper required by structural loads.

1. Aluminum Plate and Sheet: ASTM B209 (ASTM B209M).
2. Aluminum Extrusions: ASTM B221 (ASTM B221M).
3. Extruded Structural Pipe and Round Tubing: ASTM B429/B429M, standard weight (Schedule 40).
4. Drawn Seamless Tubing: ASTM B210 (ASTM B210M).

C. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Complying with performance requirements indicated and suitable for exposure conditions, supporting structure, anchoring substrates, and installation methods indicated. Corrosion-resistant or noncorrodible units; weather-resistant, tamperproof, vandal- and theft-resistant, compatible, nonstaining materials. Provide as required for awning assembly, mounting, and secure attachment. Number as needed to comply with performance requirements and to maintain uniform appearance; evenly spaced. Where exposed to view, provide finish and color as selected by Architect from manufacturer's full range.

1. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing according to ASTM E488 conducted by a qualified independent testing and inspecting agency.

    a. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or A4).

2. Adhesive-Bonded Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing according to ASTM E1512 conducted by a qualified independent testing and inspecting agency.

    a. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or A4).

D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

2.5 AWNING FABRIC FABRICATION

A. Fabrication: Reinforce wear points and hardware attachment points with webbing. Seam fabrics as follows and as appropriate for fabric types:

1. Fabric Edges and Seams: Fold and stitch selvedge and cut fabric edges.
2. Fabric Edges and Seams: Hot cut and sealed.
3. Fabric Edges and Seams: Radio-frequency welded.
4. Fabric Edges and Seams: Adhesively bonded.

5. Fabric Edges and Seams: Manufacturer's standard hemming and seaming methods.
6. Fabric Attachment: Manufacturer's standard.

2.6 FIXED AWNING FABRICATION

A. Manufacturers: As noted above

1. Frame Fabrication: Fabricate awning frames from steel or aluminum. Preassemble in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations.
2. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
3. Weld corners and connections continuously. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed corners and connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
4. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure awnings in place and to properly transfer loads.

B. Steel Finish: Manufacturer's standard primed and top-coated decorative finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

1. Color: black

C. Aluminum Finish: Mill finish complying with finish manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

1. Color: Aluminum finish

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install awnings at locations and in position indicated, securely connected to supports, free of rack, and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with Shop Drawings and fabricator's written instructions.

B. Weld frame connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

C. Anchoring to In-Place Construction: Use anchors, fasteners, fittings, hardware, and installation accessories where necessary for securing awnings to structural support and for properly transferring load to in-place construction.

D. Corrosion Protection: Coat concealed surfaces of aluminum that come in contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

E. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by retractable-awning manufacturer.

END OF SECTION 107313

SECTION 108813 – BIRD CONTROL DEVICES

PART 1 - GENERAL

1.1 - SYSTEM DESCRIPTION:

A. Bird-Net Bird Exclusion Netting is constructed of black high density polyethylene (HDPE) that is abrasion, flame, rot and UV resistant. The 3/4” (19 mm) square mesh keeps pest birds of all sizes. It can be adapted to almost any bird exclusion application. All Bird-Net Bird Exclusion Net pieces are both seamless and borderless for clean edges and easier perimeter fastening.

B. Bird Netting Hardware fastens the bird netting to all types of surface shapes and materials. A variety of netting installation tools and accessories are available to make the netting installation an efficient process.

C. Surface Cleaning System: surface disinfectants and deodorizers to neutralize potentially hazardous bird and/or animal wastes and properly prepare the surface for installation.

1.2 – RELATED REQUIREMENTS

A. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.3 - QUALITY ASSURANCE

A. Installer to obtain, review and understand all of Nixalite of America Inc.’s planning guidelines, estimating worksheets and installation instructions for the Bird-Net Bird Exclusion Netting.

B. Installer must be completely familiar with the proper installation procedures for the Bird-Net Bird Exclusion Netting and the specified mounting system.

C. Installer must obtain and record accurate and complete dimensions that define the areas specified for enclosure by the Bird-Net Bird Exclusion Netting. Accurate dimensions drive the bird netting and net hardware quantities. Accurate dimensions ensure accurate quotations and material orders.

D. Installer should contact manufacturer for any updated or newly developed planning or procedural information that may be pertinent to the Bird-Net installation.

E. Installer to ensure that bird netting meets or exceeds ISO 1806 Mesh Strength Standards.

1.4 – SUBMITTALS – NOT USED

1.5 – STORAGE & HANDLING

A. Provide storage to keep all Bird-Net Bird Exclusion Netting system boxes dry, clean and undamaged. Do not stack or place other packaging or objects on the bird netting shipping boxes.

B. Keep the Bird-Net Bird Exclusion Netting system in original packaging until needed for installation.

PART 2 - PRODUCTS

2.1 – ACCEPTABLE MANUFACTURER

A. Nixalite of America Inc
1025 16th Avenue, PO Box 727, Dept. NI, East Moline, Illinois 61244; U.S.A.
P: 800.624.1189 or 309.755.8771 - F: 800.624.1196 or 309.755.0077
E: birdcontrol@nixalite.com or planning@nixalite.com
www.nixalite.com

B. ABC Advanced Bird Control – A division of Nixalite of America Inc.
PO Box 727, Dept. NI, East Moline, Illinois 61244, U.S.A.
P: 888.212.8682 or 309.755.4708 - F: 309.755.1865
E: info@abcbirdcontrol.com
www.abcbirdcontrol.com

2.2 – BIRD-NET BIRD EXCLUSION NETTING

A. Material: High density polyethylene (HDPE) that is abrasion, UV, flame and rot resistant. Netting to be water proof.

B. Color: Black.

C. Construction: Knotted square mesh netting. Comprised of 3/4” (19 mm) square mesh. Bird-Net has a 46 lbs. (21 kg) knotted breaking strength. All Bird-Net netting pieces are both seamless and borderless for clean edges and easier perimeter fastening.

D. Standards: Bird-Net must meet or exceed ISO 1806 Mesh Strength Standards.

E. Mesh size & Applications:
3/4” (19 mm) square mesh for small and large pest birds.

F. Netting Sizes:
Widths: 25’ (7.6m), 50’ (15.2m) and 100’(30.4m).
Lengths: 25’ (7.6m), 50’ (15.2m) and 100’ (30.4m).

G. Warranties:
Black Bird-Net has a 10 year limited warranty.

H. Thermal & Physical Properties:
1. Melting point: 250 F^{o} (145 ^{o}C)+.
2. Can withstand 500^{o}F (260 ^{o}C) for short period of time
3. Remains flexible at very low temperatures.
4. Specific gravity: 0.96 – will not absorb water.
5. Chemically inert. Resistant to acids and alkalis at room temperature.

2.3 BIRD NETTING HARDWARE

A. Installer to contact manufacturer for up-to-date information and recommendations for bird netting hardware applications, item combinations as well as new items and procedures.

B. Available in Tensioned Cable Hardware system, the Poly Hardware system or a hybrid system that combines methods from different fastening procedures. Choose the hardware system that best suits the netting installation and conditions.

C. Tensioned Perimeter and Support Cable Hardware System: Choose the Connection, Corner, Cable Guide and Finishing hardware that best suits the installation surface. Net Hardware can be mixed to suit changing surface materials and conditions.

D. Net Cable & Connection Hardware:

a) Net Cable: Aircraft grade, all stainless steel, 7 x 7 (49 strand), 3/32” (2.2 mm) diameter cable with 900 lb. (407 kg) breaking strength. Net Cable comes in 250’ (76.2 m) and 500’ (152.4 m) spools.

b) Turnbuckles: Stainless steel, hook & eye turnbuckles. The size of the turnbuckle is determined by the maximum continuous cable length of any one cable run.
For one Small Turnbuckle the max continuous cable length is 25 ft. (7.6 m).
For one Medium Turnbuckle the max continuous cable length: 50 ft. (15.2 m).
For one Large Turnbuckle the max continuous cable length: 75 ft. (22.9 m).

c) Net Ferrules: Zinc plated copper core crush ferrules for 3/32” (2.2 mm) dia. cable. Acceptable connection when the max continuous cable length is 25 ft. (7.6 m) OR LESS. Always use at least 2 ferrules per cable loop connection. Always use Nixalite’s Cable Swaging Tool to crush the ferrules onto the cable at all loop connections. Always use a Cable Thimble with Net Ferrules.

d) Wire Rope Clamps: Galvanized or stainless steel wire rope clamps for 3/32” (2.2 mm) diameter cable. Mandatory for all loop connections on cable runs of 25’ (7.6 m) OR MORE. Always use 2 clamps per cable loop connection or more. Always use a Net Cable Thimble with wire rope clamps. Use the appropriate wrench or hex driver to tighten the Wire Rope Clamp around the Net Cable at all loop connections.

e) Cable Thimble: Forged stainless steel Cable Thimble for 3/32” (2.2 mm) diameter cable. The Thimble prevents cable fraying and creasing when creating loop connections and/or tensioning the Net Cable after installation. One Thimble is required for each loop connection.

E. Corner Hardware (Anchoring):

a) Eyebolts: Use as corner hardware in steel, thick sheet steel, cast iron, masonry and stone (with Machine Screw Anchors). Extreme duty stainless steel eyebolt, 2” (51 mm) long, 9/16” I.D. (14.3 mm) with 1/4-20 NC threads and stainless steel hex nut. Maximum distance between eyebolts: 50’ (15.2 m).

To fasten to Steel: If back of steel is accessible, drill clearance hole for stem, apply adhesive in hole, install eyebolt and use ¼ - 20 NC hex nut to secure. If back of steel is not accessible, drill then tap the hole for ¼ - 20 NC thread. Apply adhesive into hole, apply thread locker on eyebolt threads. Install the eyebolt.

To fasten to Masonry: Drill the recommended hole diameter and depth in the masonry surface to receive the Machine Screw Anchors. Apply adhesive/sealer in the hole. Push Machine Screw Anchor into the hole and seat it properly with the Setting Tool. Thread eyebolt into the anchor threads until tight.

b) Screw Eyes: Use as corner hardware in wood and wood core surfaces. Extreme duty stainless steel screw eyes 2” (51 mm) long, 17/32” I.D. (13.5mm). Pilot holes recommended. Apply adhesive sealer into pilot holes before installing the Screw Eyes. Maximum spacing between screw eyes: 50’ (15.2 m).

c) Machine Screw Anchor: Zinc plated anchor – 1/2” (12.7mm) diameter x 1” (25.4mm) deep with 1/4-20 threads inside. Setting tool included with anchors.

F. Cable Guide Hardware:

a) Small Screw Eyes: Use to keep cable close to the installation surface. Use on wood, sheet metal and wood core surfaces. Heavy duty, stainless steel, 1-3/16” long x 7/32” I.D. (31 mm long x 5.3 mm I.D.). Maximum spacing: 24” (61 cm) O.

C. Pilot holes recommended. Apply adhesive/sealer in all pilot holes before installing the Screw Eyes.

b) Small Eyebolts: Use to keep cable close to the installation surface. Use on steel, thick sheet metal and masonry surfaces. Heavy duty, stainless steel, 1 3/8” long x 9/32” I.D. (35 mm long x 7.1 mm I.D.) with stainless steel hex nut. Maximum spacing: 24” (61 cm) O. C.

To fasten to Steel: If back of steel is accessible, drill clearance hole for stem, apply adhesive in hole, install eyebolt and use 10 - 24 NC hex nut to secure. If back of steel is not accessible, drill then tap the hole for 10-24 NC thread. Apply adhesive into hole, apply thread locker on eyebolt threads and install the eyebolt.

To fasten to Masonry: Drill the recommended hole diameter and depth in the masonry surface to receive the Machine Screw Anchors. Apply adhesive/sealer in the hole. Push Machine Screw Anchor into the hole and seat it properly with the Setting Tool. Thread eyebolt into the anchor threads until tight.

c) Sidewinders: for heavy gauge sheet metal, structural steel up to 1/2” thick and masonry surfaces. Maximum spacing: 24” (61 cm) O. C. All Sidewinders to be installed with the Sammy Socket. No substitutions.
Sidewinders for steel are self-drill, self-tap items, no pilot hole is required. Sidewinders for concrete require ¼” (6.35 mm) diameter and 2” (50.8 mm) deep drilled holes. Apply adhesive/sealer into the drilled holes and install the Sidewinder Sammy Socket Driver.

d) E-Z Clip: Use to keep cable close to the installation surface. Stainless steel bracket holds cable very tight to surface. Used on all types of installation surfaces. E-Z Clip has mounting hole(s) for 1/8” shank screws or nails (not supplied).

e) Hammer-On Flange Clips: Used to keep cable close to the installation surface. Hammer-On Flange Clips are available in block oxide coated spring steel or stainless steel. Hammer-On Flange Clips routes the Net Cable parallel to the outer edges of beams or other structural steel flanges. Contact manufacturer for installation guidelines.

f) Stainless Steel Angle Bracket: Used to keep the Net Cable close to the installation surface. A 90° stainless steel angle bracket with two (2) holes – one for mounting the other for the cable. Fasten with the appropriate fastener (not supplied). Use stainless steel screws or nails. Apply adhesive/sealer over head of installed hardware.

g) HD Stainless Steel Cable Clamp: Used to keep the Net Cable close to the installation surface. A heavy duty saw-tooth edge clamp that fits up to 3/4” (19.0 mm) thick steel. Routes the Net Cable parallel to the outer edges of beams, plates and other structural steel flanges. Contact manufacturer for installation guidelines.

h) Stainless Steel J-Clamp: Used to keep the Net Cable close to the installation surface. A J-shaped strap of stainless steel with mounting and cable guide holes. Fasten with the appropriate fastener (not supplied). Use stainless steel screws or nails. Apply adhesive/sealer over head of installed hardware.

i) Stainless Steel Lag Screw w/eyelet: Used to keep the Net Cable close to the installation surface. Fastens to wood, composite, wood core products. Drill pilot hole, apply adhesive/sealant in pilot, install Lag Screw so eyelet is no more than 1/2” (12.7 mm) above the installation surface.

G. Finishing Hardware:

a) Net Rings: Three (3) styles of stainless steel net rings used to attach the netting mesh to the cables, to close openings in the netting mesh and to fasten the Net Zippers to the netting.
Net ring quantity requirements per attachment:
Netting to Cable: 16 net rings per foot (each netting mesh).
Lapped Seams: 32 net rings per foot (1 ring per mesh on each side of seam).
Net Zipper Installation: 32 net rings per foot (1 ring per mesh on each side of zipper).

b) Net Zipper: Allows for access to areas behind the bird netting installation. Available in 2 ft. (61 cm), 4 ft. (122 cm), 6 ft. (183 cm) and 8 ft. (244 cm) lengths. Heavy duty, marine-grade, black Net Zipper with 3/4” (1.9 cm) heavy fabric tape, open top and auto lock slider.

I. Poly Hardware: All poly hardware is made from UV stabilized black polypropylene. While it can be used to install the Bird-Net HT Bird Netting, it is more commonly used with the PollyNet line of bird exclusion netting. Poly Hardware combinations can be mixed to suit changing surface materials and conditions.

a) Poly Clip: Perimeter fastening. The Poly Clip can be fastened to the cable of a tensioned perimeter cable system or it can be snapped shut over the outer edges of the bird netting. Secure to the installation surface with the appropriate fastener (not supplied). Maximum spacing: 12” (30.5 cm) O. C.

b) Net Ties: Multi-purpose fastener. Quickly fastens the netting fabric to all types of objects. Use to prevent netting sag or loose fitting nets by securing the netting to objects above or behind netting installation. Three sizes to choose from.

c) Poly Cord: Multi-purpose fastener. Reinforce seams, patch tears, close circular openings, use for overhead support. NOT for perimeter fastening.

2.4 – SURFACE DISINFECTANTS

A. Steri-Fab: Surface disinfectant and bactericide designed to neutralize bird waste, making it safe for removal. Steri-Fab quickly kills disease causing bacteria, parasites, fungi, insects, etc. This is a non-residual product. It becomes completely inert after it dries. Do not use with Microcide-SQ on the same surface at the same time.

B. Microcide-SQ: A broad spectrum disinfectant, cleaner and deodorizer used to sanitize hard surfaces as well as fabrics and clothing. Use to kill a wide spectrum of organisms and disease causing bacteria. Do not use with Steri-Fab on the same surface at the same time.

C. Microsan: Anti-microbial personal protection products to help prevent disease transmittal before, during and after working on and around surfaces contaminated with bird and animal wastes. Use to compliment personal protection equipment standards (PPE).

D. Safety Equipment: Nixalite offers personal protection equipment (PPE) to protect personnel from the hazards related to pest bird and animal waste materials.

PART 3 - EXECUTION

3.1 - INSPECTION

A. Visually inspect the surfaces that will receive the netting hardware and all areas that will end up behind or inside the netting installation. Note damaged surfaces or incomplete construction that could compromise the bird netting installation.

B. Note all areas, surfaces or objects that may require maintenance or periodic replacement after the bird netting is installed (i.e. lights, electrical equipment, etc.). Use the appropriate netting accessories to allow access behind the installed netting system.

C. Note any objects or conditions that could damage the installed bird netting. Install the Bird-Net in such a manner as to avoid these conditions.

3.2 - PREPARATION

A. Field Measurements: Verify the dimensions for each area specified for enclosure with the Bird-Net Bird Exclusion Netting. Use manufacturers Planning Guides and Estimate Worksheets to verify that sufficient quantities of bird netting and net hardware will be installed at each location specified for bird netting.

B. Make sure all installation surface finishing requirements have been accomplished before installing the Bird-Net Bird Enclosure Netting. Bird netting is to be the last item installed on each specified surface. DO NOT apply any surface coating or treatment (paint, sealer, etc.) over or on the installed Bird-Net Bird Exclusion Netting or the mounting hardware.

3.3 – SURFACE CLEANING

A. All surfaces to be clean, dry and free of obstructions before the Bird-Net Bird Exclusion Netting is installed.

B. If Bird Waste Is Present:
Treat, neutralize and safely remove all bird waste from installation surfaces. Installer must follow all municipal, state and federal regulations regarding the proper removal and disposal of bird droppings and waste materials such as nests and dead birds.

C. Use Nixalite’s surface cleaning products to neutralize any bird droppings, nests and related waste materials that may be present. Allow all surfaces to air dry completely, and then reapply to sanitize and deodorize the surface before proceeding. Strictly follow treatment instructions provided with Nixalite’s surface cleaning products.

D. Use Nixalite anti-microbial and anti-bacterial personal protection products to help prevent disease transmittal when working around surfaces contaminated with bird droppings.

3.4 - INSTALLATION

A. Make sure the installation surfaces are clean, dry and free of any debris or obstructions.

B. Install the bird netting hardware as recommended by manufacturer. General order of installation is to install all the Corner hardware, cable guides and connection hardware. Run the Net Cable through the net hardware. Leave the turnbuckles loose.

C. Install Bird-Net Bird Exclusion Netting as recommended by the manufacturer. If necessary cut the Bird-Net to fit the area. If multiple pieces are needed, join the pieces together with the recommended Net Ring hardware. Use the Net Rings to fasten the netting mesh to the perimeter and support cables. Tighten the turnbuckles to eliminate any wrinkles in the netting.

D. Install Bird-Net Bird Netting to avoid contact with machinery, vehicles, extreme heat, tree branches, etc. Make necessary adjustments to keep netting a sufficient distance from these objects or conditions.

E. Finished Bird-Net installation to be taught, free of wrinkles, gaps and openings.

3.5 – ADJUSTMENTS / CLEANING

A. Remove net or cable hardware debris and waste from project site. Inspect finished installation. Make any adjustments needed to conform to Nixalite's bird netting installation guidelines.

B. Bird-Net Bird Exclusion Netting is a physical and passive barrier. It relies on optimal placement and proper installation. Exclusion netting must block off or seal up all routes and paths that pest birds follow to their preferred roosts. Periodic inspections are recommended to make sure the bird netting stays in good condition.

C. Note any holes, gaps or openings in the bird net installation that birds can use to bypass or get around the netting barrier. Correct these conditions immediately.

END OF SECTION 108813

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SECTION 110800 - COMMISSIONING OF EQUIPMENT

PART 1 GENERAL

2.01 SUMMARY

A. See Section 019113 - General Commissioning Requirements for Contractor's commissioning responsibilities and Commissioning Scope of Work, including a list of systems to be commissioned. Comply with requirements of Section 019113.

B. The Commissioning Authority (3PCx) directs and coordinates all commissioning activities as described in Section 019113.

2.02 RELATED REQUIREMENTS

A. Section 019113 - General Commissioning Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

5.01 OPERATION AND MAINTENANCE MANUALS

A. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

B. See Section 017800 for additional requirements.

END OF SECTION

SECTION 111300 - LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dock Leveler
2. Edge of Dock Leveler (Hydraulic)
3. Edge of Dock Leveler (Pneumatic)
4. Dock Shelters
5. Dock Bumper.
6. Truck Restraint Device and Communication System.
7. Combination Dock Light and Fan.
8. Track Guard.

B. Related Requirements:

1. Section 031000 – Concrete Forming and Accessories: Placement of leveler frame into concrete loading dock.
2. Section 033000 - Cast-in-Place Concrete: Concrete pit.
3. Section 055000 - Miscellaneous Metals: Dock edge angles
4. Division 26 - Electrical: Power wiring and control wiring conduits for dock equipment.

1.2 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide materials and finish, installation details, roughing-in measurements, and operation of unit.

C. Shop Drawings: Indicate required opening dimensions, tolerances of opening dimensions, perimeter conditions of construction.

D. Operation Data: Provide operating instructions, identify unit limitations.

E. Maintenance Data: Provide unit maintenance information, lubrication cycles, spare parts manual.

1.3 WARRANTY

A. Proposals submitted without the following written warranties will be considered non-responsive.

1. This warranty is based on a standard fork lift truck operating procedure. A standard procedure is; no load shall exceed the rated lift capacity of the truck, and no load shall be pre-staged or stacked and pushed or pulled over the dock leveler into or out of the truck.
2. Dock leveler manufacturer shall provide with his bid a written 10 year money back Structural Warranty on dock levelers (including Edge Of Dock levelers). Warranty shall be based on the following criteria:

a. Gross weight of fork lift and load shall not exceed 14,000 lbs.
b. User's operations shall not exceed 6 full truck loads per 24 hour period over any one dock position.

c. Lift truck speed shall be no more than 5 mph. Leveler grade shall be no more than the recommended grade as determined by the material handling equipment manufacturer and never more than 7.17%.

B. All parts not covered under the 10 Year Structural Warranty will have a 2 year parts, 2 year labor warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Kelley Company; Product HK Series: www.kelleycompany.com. Contact:

   Chuck Zimmermann Manager, National Accounts
   Entrematic-Loading Dock Products, N56 W24701 Corporate Circle Sussex, WI 53150, M:414-745-8477, email: chuck.zimmerman@4frontes.com

2. Rite-Hite Corp; www.ritehite.com. Contact:

   Josh Morgan
   Arbon Equipment Corporation, 22718 58th Place South Kent, WA 98032
   O:253-395-7099 M:253-951-5694, email: jmorgan@ritehite.com
   Pierce Marrs
   Office: (253) 395-7099, Mobile: (615) 473-1469, e-mail: PMarrs@ritehite.com

3. Poweramp; www.loadingdocksystems.com. Contact:

   Jeff Schulze Systems, Inc.
   W194 N11481 McCormick Drive Germantown, WI 53022
   O:800-643-5424 M:920-716-1510, email: jeffschulze@loadingdocksystems.com

4. Blue Giant Equipment Corp.: www.bluegiant.com. Contact:

   David Rimmer
   Phone (647) 501-3126
   Email: drimmer@bluegiant.com

5. Substitutions: Not permitted.

2.2 DOCK LEVELER (PIT HYDRAULIC)

A. Acceptable Manufacturers

1. Kelley Company: HK Series
2. Rite- Hite.: RL Series- HL987-40K
3. Poweramp: LHP Series- LHP-78
4. Blue Giant: H Series – H7008H

B. Description:

1. Operation: Hydraulic.

    a. Provide electric hydraulic raising and hydraulic lowering of the ramp, controlled from a remotely located push-button station. Provide a hydraulic velocity fuse to limit the loaded ramp's free fall to not over 3 inches.

2. Deck Size: Nominal 7 feet x 8 feet.
3. Operating Range: 12 inches above dock level, 12 inches below dock level. Provide an operating range above the platform level of sufficient height to enable the lip to extend and clear the truck bed before contact
4. Capacity: 40,000 lbs. in accordance with ANSI MH30.1-2015.
5. Automatic Vertical Compensation: Floating travel of the ramp with lip extended and resting on the truck bed shall compensate automatically for upward or downward movement of the truck bed during loading and unloading.
6. Automatic Lateral Compensation: Tilting of the ramp with lip extended and resting on the truck bed shall compensate automatically for canted truck beds of up to 4 inches over the width of the ramp
7. Lip Operation: Provide the manufacturer’s standard mechanism that automatically extends and supports the hinged lip on the ramp edge with the lip resting on the truck bed over the dock leveler’s working range, allows the lip to yield under impact of the incoming truck, and automatically retracts the lip when the truck departs.
    a. Lip length shall be 16 inches typical.
8. Leveler Stored Switch: Factory installed and wired to Master Control Panel.
9. Finish: Manufacturer’s standard paint applied to factory assembled leveler before shipping.
10. Dock Leveler Control Box: All individual components, as well as the complete box unit, shall be UL-approved 460v/3P single enclosure. This enclosure shall operate both the dock leveler and dock restraint and contain a step down transformer for the trailer restraint. This shall allow for one incoming power source.

    a. Include hard wired connection to fan and dock light and include individual switch capability.

11. Accessories:

    a. Night locks.
    b. Safety stops.
    c. Toe guards integral for full operating range, painted safety yellow.
    d. Side and rear weather seals.
    e. Safety Strut: Integral, permanently attached to unit.

2.3 EDGE OF DOCK LEVELER (HYDRAULIC)

A. Acceptable Manufacturers

1. Kelley
    a. Models: KH Series (Hydraulic)

2. Rite-Hite
    a. Models: RHE Series (Hydraulic)

3. Poweramp
    a. Model HED Series (Hydraulic)
    b. Model HNL Series (Hydraulic)

4. Blue Giant Equipment Corp
    a. Models: MD-CH Series (Hydraulic)

B. Description:

1. Operation: Hydraulic.

    a. Platform mounted to the edge of a building wall to assist loading and unloading of trailers in a limited working range of 3 inches above to 3 inches below dock.
    b. Provide electric hydraulic raising and hydraulic lowering of the ramp controlled from a remotely located push-button station. Provide a hydraulic velocity fuse to limit the loaded ramp's free fall to not over 3 inches.

2. Platform Width: 84 inches (7'-0")
3. Platform Length: 27 inches
4. Platform Deck Thickness: ½" high tensile steel safety tread plate with abrasive non-skid finish.
5. Lip Operation: Provide the manufacturer's standard mechanism that extends and supports the hinged lip on the ramp edge with the lip resting on the truck bed over the dock leveler's working range, allows the lip to yield under impact of the incoming truck and automatically retracts the lip when the truck departs. Lip to have a 12-15 inch extension (depending on manufacturer), ½" thick high tensile steel safety tread plate on 40K-45K with abrasive non-skid finish.
6. Bumpers: unit to include two tire laminated bumpers mounted to steel block assemblies with minimum projection of 16 inches and maximum of 18 inches. Maximum 1" gap between dock leveler plate and bumper. Maximum 1" gap between dock shroud and bumper.
7. Operating Range: 3 inches above dock level, 3 inches below dock level.
8. Side to side cross-tilt: over width of ramp must be eliminated.
9. Capacity: 30,000 lbs. in accordance with ANSI MH30.1-2015.
10. Identification: Attached to dock leveler stating:

    a. Capacity
    b. Name of Manufacturer
    c. Model Number
    d. Serial Number

11. Standard Features:

    a. Built-in maintenance locking bar
    b. Remote mount power unit and solenoids
    c. Yieldable lip under impact of incoming vehicle.
    d. Hydraulic safety stop.
    e. Hinged bottom draft pad
    f. Leveler to power down to loading position via constant pressure push-button.
    g. Provide rear-mounting channel equipped with engineered concrete anchoring devices and factory attached leveler hinge points. Embed and leveler structure to have no attachment to the pit floor and a minimum 2" clearance from structure to pit floor at any point for easy cleaning.
    h. Hydraulic lip extension to be dual acting type, powered both on extension and retraction.
    i. Run-off guard on the leveler deck to be ½" thick by 4" high minimum.
    j. Main hydraulic cylinder to have adjustable stroke mounting point. Provide vertical style, laminated rubber bumpers with riser brackets designed for both the door size and to raise top of bumper from shelf or pit floor level with finished floor.

12. Options:

    a. Control Panel: Combo / Master Panel
    b. Bumper Type: Vertical Steel Faced 4x20x11
    c. Deck Mount Power Unit: None (Remote mount standard)

13. Motor (Hydraulic) Operations:

    a. Electric power pack (includes motor, pump and valve assembly) of 1 HP, 480 volt 3 phase motor
    b. Remote Control Station: Constant pressure push button station complying with NEMA 4.
    c. Constant Pressure on Control Button: Raise unit.
    d. Platform operated by hydraulic cylinder.
    e. Engineer unit to “free float” with truck bed.

2.4 EDGE OF DOCK LEVELERS - PNEUMATIC:

A. Existing Pneumatic - Acceptable Manufacturers:

1. 4Front Engineered Solutions / Kelley Company:

    a. KA Series

B. Existing Manual

1. Replace with new hydraulic equipment

2.5 DOCK SHELTERS

A. Acceptable Manufacturers:

1. Kelly Company – SHFS-HG
2. Dockzilla – MDL 13097
3. Rite-Hite – Eclipse NH (620NH).

B. Description: Enclosure that provides a seal against trailer top and sides, installed to keep weather out and energy in.

1. Type: Soft-sided, wrap around enclosure added to building.
2. Size: Enclosure is 11’-8” wide with side curtains that extend 12” below the building floor and 36” rain diverting head curtain.
3. Overall projection to be based on projection of existing loading dock bumpers.
4. Minimum projection of 24” past dock bumper face.
5. Side curtains shall have a double sealing leading edge, provide full access to trailer, and be removable.
6. Header shall be constructed as a canopy style header and provide a tight, consistent seal across the entire trailer top.
7. Side frame should be foam wrapped in high-strength fabric with friction-resistant surface.
8. Side frame should be impactable by trailer.
9. Collapsible bottom draft pads shall seal the gap between the sides of the trailer and the side frames.
10. Canopy top and side frame fabric shall be lightweight fabric.

2.6 DOCK BUMPERS

A. Acceptable Manufacturers:

1. Kelley Trak- Model VBR420-11F
2. Rite-Hite- Model V420-11
3. Poweramp / McGuire - Model B4520-11P1
4. Blue Giant – BGV420-11-C

B. Description: Fabric reinforced rubber pads, ozone resistant, laminated and compressed in position with two steel rods with threaded ends, washers and nuts; between 3 x 2-1/2 x 1/4 inch galvanized steel angle end plates:

1. Projection from Wall: 4-1/2 inches.
2. Size: 20 inches high x 11 inches long.
3. Location: All dock doors and trailer spaces against building wall.

2.7 TRUCK RESTRAINING DEVICE AND COMMUNICATIONS SYSTEM:

A. Manufacturer: Provide equipment from the same manufacturer as the dock leveler.
1. 4Front / Kelley – Model APS2000
2. Rite-Hite- Genisys GRH-700 Dok-Lok with Dok-Commander (Standard highway trailers only)
3. Poweramp / McGuire – TPR Vehicle Restraint with iDock Combo Panel
4. Blue Giant – HVR303

B. Truck Restraint Description:

1. Type: Upward biased restraining hook, capable of restraining 30,000 lbs of force without sustaining structural damage to the restraint. Provide steel mounting plate with anchor bolts for securing to concrete foundation wall.
2. Restraining Range: Restraint will engage underside of ICC bar between 9 inches and 30 inches above ground, measured on a level surface.
3. Operation: Powered operation, push-button controls for engagement and return to storage.
4. Controls: NEMA 12 control panel, complete with red and green LED lights, and instruction label.
5. Release of restraining hook shall be actuated only from inside.
6. Provide interlock between dock door and leveler, and leveler and truck restraint. Leveler cannot raise without door in full open position, and without truck restraint in engaged position.

C. Safety Communications System:

1. Inside instruction aluminum or metal placard and flashing red and green LED lights mounted in low profile box. Outside caution sign with instructions for truck driver, and flashing red and green LED lights.
2. Interlock system to signal contact of the hook with the ICC bar, red exterior/green interior with hook engaged and green exterior/red interior with hook in stored position.
3. Dock Equipment Sequence of Operations:

a. Engage Trailer Restraint OR place in Override Mode-Outside light change to Red, inside light changes to Green.
b. Open Manual Door-Limit Switch provided by dock manufacturer, installed and wired by others. Once the door is fully open, the inside light changes to Green. Only when the dock door is fully opened and inside green LED light is on, will the dock leveler be enabled.
c. Raise Dock Leveler.
d. Dock Light On from Auto Switch Position when dock leveler leaves the stored position.
e. Store Dock Leveler-Inside Light Changes to Red.
f. Dock Light Off from Auto Position when the dock leveler is stored.
g. Vehicle restraint can only be released when the dock leveler is stored.
h. Release Restraint-Outside Light Changes to Green.

2.8 DOCK LIGHT AND FAN

A. Acceptable Manufacturers:
   1. 4Front / Kelley – HV-ES Turbo 2040HI Fan
   2. RiteHite: CoolMan 2800
   3. Poweramp / McGuire – TC14 LED Light/Fan Combo
   4. Blue Giant – FANDL40-PLED

B. Description: Combination dock light and fan on 42-inch heavy duty swing arm. High Impact LED Fixture. Light/fan shall be mechanically locked in position parallel to the floor. Cotter pin(s)/self-locking nuts or other mechanisms to be added to prevent light/fan from breaking loose after repeated cycles of use. Installation must include safety strap, steel cable or an equivalent system with 96 lb. capacity to prevent fan from falling if the locking mechanism fails. Installation must include safety stickers and visual instructions for all installation. The bracket that connects the light/fan to the swing arm should be tested to withstand the fan weight and movement and must be installed with adequate blocking and fasteners.

   1. Factory assembled, hardwired, adjustable dock light with fan.
      a. Dock light to the following requirements:

         1. The heavy-duty adjustable dock light is UL listed.
         2. The dock light includes a 42” double strut arm power with two IEC60320
         3. Operating Voltage: 120VAC/60Hz single phase operation.
         4. 16 Input Wattage.
         5. 22-inch power cord with IEC60320-C14 plug.
         6. ETL/cETL listed to
         7. UL 153 Portable Work Lights
         8. CSA C22.2 No. 12 Portable Luminaires
         9. IP67 rated.
         10. Compact head design weighing less than 4 lb.
         11. Low copper content aluminum housing.
         12. Cree XP-E LEDs.
         13. <25° beam angle.
         14. Stainless steel hardware.
         15. Impact-resistant clear polycarbonate lens conforms to FDA and USDA
         16. Requirements for food facilities.
         17. Zinc plated mounting bracket allows for 0.5-inch hardware to mount to articulating dock light arm or other.
         18. 50,000 hour expected lamp life
         19. Safety yellow housing for easy visibility
         20. 3-year limited warranty
         21. Dock light placement must allow unobstructed view into truck/line haul trailer.
         22. Top of light must not exceed 94" from finished floor

      b. Dock light arm:

         1. 42” double strut arm for increased strength and durability
         2. ETL/cETL listed to 3. CSA C22.2 No. 250
         4. Two IEC60320-C13 receptacles for separately controlled light head & fan.
         5. Safety yellow powder coated housing for easy visibility
         6. Galvanized steel mounting bracket.
         7. Outdoor-rated junction box for hard-wiring.
         8. Load assist mechanism rated for 25,000 cycle average life
         9. Gas shock assisted adjustable height in one-inch increments (up to 6 in).
         10. Spring-loaded pin and handle assembly for ease of adjustability

11. Nylon inserts to prevent metal binding
12. 180° rotation of light head
13. 40 inch total mounting footprint
14. 1-year limited warranty
15. Handle must be provided on underside of assembly to provide for safe rotation of full assembly. Assembly must be mounted 80” from finished floor to bottom of handle.

c. Dock light fan:

1. Operating Voltage: 120VAC/60Hz single phase operation.
2. 1/3 HP-3.0 AMP
3. 15-inch power cord with IEC60320-C14 plug.
4. Maximum-1275 CFM output
5. Tapered cone to provide a focused column of air
6. Protective grill for safety
7. Mounting for dock light head
8. Steel construction
9. Powder coated finish
10. 2-year limited warranty
11. Dock fan placement must allow unobstructed view into truck/line haul trailer.
12. Dock fan noise level shall not exceed 75dBA, at maximum speed.

2.9 TRACK GUARDS

A. Description: “Z” shape door track protectors made from ¼ inch thick steel shapes with wall and floor mounting flange.

1. Height: 4 feet.
2. Color: Prefinished safety yellow enamel coating.
3. Acceptable Manufacturers:

a. Kelley Trak- Sentry-HD
b. Rite-Hite- Warden Track Guard
c. Poweramp- Track Guards
d. PostGuard – ODP48
e. Global Industries – WBB1519307

B. Description: “L” shape door track protectors made from ¼ inch thick steel shapes with floor mounting flange. Use where securing to existing walls is not feasible, such as metal buildings.

1. Height: 4 feet.
2. Color: Prefinished safety yellow enamel coating.
3. Acceptable Manufacturers
   a. Global Industries – WR3652896
   b. Substitutions allowed with approval

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that rough-in openings are acceptable.

3.2 INSTALLATION:

A. Install dock equipment in accordance with manufacturer’s instructions.

B. Dock Leveler:

1. Install dock leveler unit in prepared opening in accordance with manufacturer's instructions.
2. Set square and level.
3. Anchor unit securely, flush with dock. Weld back of leveling dock to pit frame. Touch-up welds with primer.

C. Secure truck restraint device to foundation wall with anchor bolts and weld top to dock pit angle.

3.3 DOCK SHELTERS:

A. Preparation:

1. Verify wall openings are sized and aligned to tolerances.
2. Verify required anchors will fit and are compatible with size and openings.

B. Erection:

1. Erect dock shelter in accordance with manufacturer's instructions and shop drawings.
2. Attach anchors and fittings to prepared wall construction and opening frame.
3. Use galvanized fasteners permitting site adjustment and alignment.

3.4 ADJUSTING

A. Adjust installed unit for smooth and balanced operation.

B. Test dock levelers for vertical travel and adjust to maintain operating range indicated.

C. After completing installation of exposed, factory-finished loading dock equipment, inspect exposed finishes and repair damaged finishes.

3.5 MAINTENANCE

A. Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of loading dock equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper loading dock equipment operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION 111300

SECTION 124813 - ENTRANCE FLOOR MATS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes entrance flooring.

1.2 RELATED REQUIREMENTS

A. Section 016116 – Volatile Organic Compound (VOC) Restrictions

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Installer Qualifications: An established firm with experience in the installation of the specified product and have access to all manufacturers required technical, maintenance, specifications, and related documents.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and protect materials under provisions of Section 016000.

B. Packing and Shipping:

1. Deliver materials in Manufacturer’s original, unopened, undamaged packaging.

C. Storage and Protection:

1. Store materials in original undamaged packages and containers, inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity; laid flat, blocked off ground to prevent sagging and warping.
2. Keep materials dry. Protect stored on-site and installed absorptive materials from moisture damage.
3. Verify that installed materials and products are dry prior to sealing and weatherproofing the building envelope.
4. Install interior absorptive materials only after building envelope is sealed and weatherproofed.

1.5 PROJECT CONDITIONS

A. Environmental Conditions: Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Field Measurements: Where possible, verify actual measurements by field measuring before fabrication and include measurements in shop drawings. To avoid construction delays, coordinate field measurements and fabrication schedule based upon construction progress.

1.6 SEQUENCING AND SCHEDULING

A. Install products after other finishing operations, including painting, have been completed.

B. Delay installation of mats until near time of substantial completion for the Project.

PART 2: PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturer:

1. As indicated on the Drawings.
2. Substitutions: None.

2.2 ENTRANCE FLOORING (CPT-2)

A. Basis of Design Product: As indicated on the Drawings.

1. Manufacturer: Matworks
2. Surface Design: Carpet - Diamond Mat II.
3. Application: ¼ turn pattern, direct glue down.
4. Thickness: 7/16-inch (10.5mm) thick mat.
5. Size: 19.5” x 19.5” Tile
6. Border: Rubber Border, black, when not installed wall to wall.
7. Color: DM01 ‘Charcoal’.

PART 3: EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean substrate surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the Project conditions.

3.3 INSTALLATION

A. Install entrance mat in accordance with manufacturer’s installation instructions. Coordinate installation with adjacent work to ensure proper clearances and to prevent tripping hazards.

B. Shop fabricate units of floor mat to greatest extent possible in sizes as indicated. Where not indicated otherwise, provide single unit for each mat installation, but do not exceed manufacturer's maximum size recommendation for units intended for removal and cleaning.

1. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes.
2. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.
3. Verify sizes by field measurement before shop fabrication.

3.4 CLEANING

A. Clean entrance mat, tiles, and frames as recommended by the manufacturer. Do not use materials or methods which may damage materials or surrounding construction.

3.5 SITE ENVIRONMENTAL PROCEDURES

A. Indoor Air Quality:

1. Temporary Ventilation: Provide temporary ventilation during work of this Section.

a. Ventilate products prior to installation. Remove from packaging and ventilate in a secure, dry, well-ventilated space free from strong contaminant sources and residues. Provide a temperature range of 60 degrees F minimum to 90 degrees F maximum continuously for minimum 72 hours.

3.6 PROTECTION

A. Protect installed products until completion of Project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 124813

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SECTION 200548 - SEISMIC CONTROLS FOR MEP/F/T SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. This section includes requirements for seismic controls to be installed for project, the design for which is a delegated design responsibility.

1.2 DEFINITIONS

A. Section Title: Seismic Controls for Mechanical, Electrical Plumbing, Fire Protection, and Technology (MEP/F/T) Systems.

B. IBC: International Building Code.

C. ICC-ES: ICC-Evaluation Service.

D. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.3 ADMINISTRATIVE REQUIREMENTS

A. The contractor shall be responsible for determining the requirements for seismic control measures to be applied to HVAC piping and equipment, electrical conduit and raceways, electrical switchgear and plumbing systems specified herein. Seismic protection criteria used to determine seismic control requirements of all mechanical, electrical and plumbing systems shall be determined by the applicable code adopted in the project jurisdiction. Where not already determined within the contract documents, the contractor shall be responsible for contracting a licensed professional engineer to establish building site class, seismic use group, occupancy category, seismic design category, seismic zone or any other criteria necessary to determine the requirements for seismic control measures for mechanical, electrical and/or plumbing systems.

B. Where required, the Contractor shall be responsible for determining the type and location of seismic supports required for the HVAC piping and equipment, electrical conduit and raceways and plumbing elements shown on the contract drawings based on the seismic criteria, the size and weight of the supported element and the distance from structure that the element will be installed. The Contractor shall submit shop drawings as defined in Paragraph “Submittals” showing the types and locations of required seismic supports.

C. The requirements for seismic control measures to be applied to HVAC piping and equipment, electrical conduit and raceways, electrical switchgear and plumbing systems specified herein are in addition to any other items called for in other sections of these specifications. All anchor connections to structure for support of mechanical/electrical equipment, regardless of the need for seismic restraints, shall be shown on shop drawings and submitted for review by the Engineer of Record.

D. At the Contractor’s option, use pre-engineered seismic restraints produced by the manufacturers specified in part 2.1 of this section. Spacing of seismic restraints may be modified in these pre-engineered systems to meet seismic design parameters when properly engineered and documented.

E. All seismic restraints, isolators, and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.

F. Seismic protection systems shall be installed in strict accordance with all applicable local, state, and/or federal codes. Installation shall also be in strict accordance with component manufacturer's requirements and standards and with industry construction standards. Whenever conflicts occur between codes or standards, the most stringent shall apply.

G. Seismic protection of fire protection piping systems shall be installed in strict accordance with the provisions of NFPA 13 (2010 or later edition).

1.4 SUBMITTALS

A. Seismic Control Measure Analysis: The contractor shall provide an analysis determining the requirement or exemption for seismic control measures for mechanical, electrical and plumbing equipment. The analysis shall be signed and sealed by a licensed professional structural engineer.

1. The analysis shall at a minimum include the following:

a. For projects permitted under Uniform Building Code

1) UBC Seismic Zone
2) Seismic Zone Factor
3) Occupancy Category

b. For projects permitted under International Building Code

1) Seismic Use Group or Building Category.
2) Seismic Design Category
3) Site Class
4) Design Spectral Response Acceleration Values

c. For projects with equipment mounted outdoors and subject to wind restraint requirements:

1) Basic Wind Speed.
2) Building Classification Category
3) Minimum 10lb/sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

B. Where seismic control measure analysis determines seismic controls are not required:

1. Submit report that summarizes the analysis for review and approval.
2. Disregard the remaining portions of this submittal section

C. Where seismic control measure analysis determines seismic controls are required:

1. Submit report that summarizes the analysis for review and approval
2. Provide submittals for seismic bracing as required in the remaining portions of this submittal section.

D. Product Data: The manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

E. Delegated-Design Submittal: Submit seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators and seismic restraints.

a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Seismic and Wind Restraint Details:

a. Design Analysis: Submit report that supports selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
c. Preapproval and Evaluation Documentation: Where required provide preapproval documentation from an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

F. Shop Drawings: The following items shall be signed and sealed by a registered professional engineer:

1. Shop drawings along with catalog cuts, templates, erection, and installation details, as appropriate, for the items listed below shall be submitted for approval. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to other building systems and construction.

a. Sway Braces
b. Flexible Couplings or Joints
c. Resilient Type Vibration Devices
d. Equipment Anchor Connections
e. Fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
f. Details of suspension and support for ceiling hung equipment.
g. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

h. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

2. Layout drawings showing locations and types of seismic restraints for all equipment, ductwork, piping and conduit shall be submitted. Locations for seismic restraints shall be coordinated with the structure and with other mechanical and electrical components. Coordinate types of restraints with the submitted schedule
3. Indicate components exempt from seismic due to exceptions for component importance factor, component response modification factor, component amplification factor, seismic design category, etc.

G. Seismic Certification and Analysis:

1. Seismic restraint calculations shall be provided for all connections of equipment to the structure. Calculations shall be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the project location.
2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Testing and calculations shall include shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
3. Analysis shall indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the code required forces acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.
4. Submit certification letter stating that the special inspector has received the factory training necessary to perform the field inspection specified in Part 3 of this specification.

H. Welding certificates.

1.5 QUALITY ASSURANCE

A. Professional Engineer Qualifications (Analysis): The professional engineer shall be licensed to practice in the jurisdiction where the project is located and shall be experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for building structural and seismic requirements.

B. Professional Engineer Qualifications (Design): The professional engineer shall be legally qualified to practice in the jurisdiction where the Project is located and shall be experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of vibration isolation bases and seismic restraints that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

D. Seismic Restraint Manual: A seismic restraint manual shall be prepared that contains the basis of the design for the seismic support systems, product data, shop drawings and layout drawings. A copy of the seismic restraint manual shall be kept on the jobsite for the duration of the project.

E. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

F. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

G. Comply with NFPA 70.

1.6 SPECIAL INSPECTION

A. Requirements specified herein for special inspection of important aspects of the seismic design are in addition to other requirements specified in other sections of this specification.

1.7 HVAC EQUIPMENT

A. HVAC equipment to be protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

1. Mechanical Equipment including but not limited to:

a. Boilers
b. Expansion Tanks
c. Heat Rejection Equipment
d. Refrigerant Compressors
e. Indoor Air Handling Equipment
f. Rooftop Air Handling Equipment
g. Packaged Rooftop Units
h. HVAC Piping and Equipment Storage Racks
i. Heat Exchangers
j. Water Chillers
k. Cooling Towers, Fluid Coolers, Condensing Equipment
l. Control Panels
m. Pumps with Motors

2. HVAC (hydronic) Piping Systems
3. HVAC Ductwork Systems

1.8 ELECTRICAL EQUIPMENT

A. Electrical equipment to be protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

1. Major Electrical Distribution Equipment including but not limited to

a. Panelboards
b. Generators
c. Switchgear
d. Transformers
e. Freestanding Disconnect
f. Control equipment (time-clocks, contactor enclosures, etc.)

2. Electrical Conduit and Raceways
3. Electrical Bussways

1.9 PLUMBING EQUIPMENT

A. Plumbing equipment to be protected shall include the following items to the extent required on the drawings or in other sections of these specifications:

1. Plumbing Equipment including but not limited to

a. Water Heaters
b. Heat Exchangers
c. Water Softeners
d. Expansion Tanks
e. Air Compressors
f. Vacuum Pumps
g. Pumps with Motors

2. Fuel Gas piping
3. Fuel Oil Piping
4. Medical Gas Piping

1.10 RELATED WORK

A. Housekeeping Pads

1. The restraint vendor shall prepare housekeeping pad reinforcement and monolithic pad attachment to the structure details and design..
2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel

1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc., as required or specified.

1.11 ATTACHMENTS

A. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the seismic vendor's calculations.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Seismic Restraints: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equals:

1. Amber/Booth Company, Inc.
2. B-Line / Tolco.
3. International Seismic Application Technology (ISAT).
4. Kinetics Noise Control, Inc.
5. Loos & Company, Inc.

6. Mason Industries, Inc.
7. Uni-Strut.
8. Vibro-Acoustics.

B. Flexible Couplings: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equals:

1. Barco Div.
2. Flexonics, Inc.
3. Hyspan.
4. International Seismic Application Technology (ISAT).
5. Mason Industries, Inc.
6. Resistoflex.

2.2 VIBRATION ISOLATORS

A. Isolator Pads: Oil and water resistant and factory cut to sizes that match requirements of the equipment supported.

1. Rubber Isolator Pads: Elastomer (neoprene or silicone) arranged in single or multiple layers and molded with a nonslip pattern and steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
2. Fiberglass or cork isolator pads: molded cork or glass fiber not less than 1 inch thick and pre-compressed through 10 compression cycles at 3 times the rated load.
3. Load range: from 10 to 50 psig and a deflection not less than 0.08 inch per 1 inch of thickness. Do not exceed a loading of 50 psig.

B. Rubber Isolator Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements, with encapsulated top- and baseplates. Factory-drilled and tapped top plate for bolted equipment mounting. Factory-drilled baseplate for bolted connection to structure. Color-code to indicate capacity range.

C. Spring Isolators: Freestanding, laterally stable, open-spring-type isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 1.0 times the rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to a 1/4-inch thick, rubber isolator pad attached to the baseplate underside. Size baseplates to limit floor loading to the structural design criteria. Contact the Engineer if design criteria is not shown on the drawings.
6. Top Plates: Provide threaded studs for fastening and leveling equipment.
7. Finishes: Manufacturer's standard corrosive-resistant finish.

D. Restrained Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring-type isolators.

1. Housing: Welded steel with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Factory-drilled baseplate for bolting to structure and bonded to a 1/4-inch thick, rubber isolator pad attached to the baseplate underside. Provide adjustable equipment mounting and leveling bolt.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 0.8 times the rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Finishes: Baked enamel for metal components on isolators for interior use. Hot-dip galvanized for metal components on isolators for exterior use.

E. Rubber Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to formed-steel housings with threaded connections for hanger rods. Color-code to indicate capacity range.

F. Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.

1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Install elastomeric grommet at bottom connection for isolation between anchor bolt and base plate or housing.
5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

2.3 SEISMIC CONTROLS

A. Thrust Restraints: Combination spring and elastomeric restraints with coil spring and elastomeric insert in compression. Factory set for thrust.

1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

B. Manufactured Seismic Snubbers: All-directional snubbers.

1. Construction: Interlocking steel members restrained by a 3/4-inch- thick, replaceable, shock-absorbing neoprene insert. Maintain 1/8-inch clearance in all directions between rigid and resilient surfaces.

C. Fabricated Seismic Snubbers: Welded structural-steel shapes designed and fabricated to restrain equipment or vibration isolation bases from excessive movement during a seismic event. Design to resist gravity forces identified by authorities having jurisdiction.

1. Construction: Welded steel shapes conforming to ASTM A 36.
2. Resilient Components: 3/4-inch thick, replaceable, shock-absorbing neoprene insert.

2.4 VIBRATION ISOLATION BASES

A. Fabricated Steel Bases: Structural-steel bases and rails designed and fabricated by the isolation equipment manufacturer. Include equipment static loadings, power transmission, component misalignment, and cantilever loadings.

1. Fabricate bases to shapes required, with welded structural-steel shapes, plates, and bars conforming to ASTM A 36. Include support brackets to anchor base to isolation units. Include prelocated equipment anchor bolts and auxiliary motor slide bases or rails.
2. Design and fabricate bases to result in the lowest possible mounting height with not less than 1-inch clearance above the floor.
3. Concrete-Filled Inertia Bases: Weld reinforcing bars to the structural frame. Pour concrete into base with relocated equipment anchor bolts.
4. Weld steel angles on frame for outrigger isolation mountings, and provide for anchor bolts and equipment support.
5. Configure inertia bases to accommodate equipment supported.
6. Pump Bases: Size to support pump and piping elbows.
7. Factory Finish: Manufacturer's standard corrosive-resistant finish.

2.5 VIBRATION ISOLATION ROOF CURBS

A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb designed to resiliently support roof-mounted equipment and to withstand 125-mph wind impinging laterally against the side of the equipment. Design restraints to meet seismic requirements of authorities having jurisdiction.

B. Components: Upper support frame; lower support assembly; freestanding, unhoused, laterally stable steel springs; vertical and horizontal restraints.

1. Lower Support Assembly: Provide a means of attachment to the building structure and include a wood nailer strip for attachment of roof material and 2 inches of rigid insulation on the inside of the assembly.
2. Spring Isolators: As indicated or scheduled. Include adjustment bolt to permit leveling of equipment after installation. Attach to lower assembly with a rubber isolation pad. Locate spring isolators so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
3. Water Seal: Elastomeric seal conforming to UL Class A roofing materials, attached to the upper support frame, extending down past the wood nailer of the lower support assembly, and counterflashed over the roof materials.

2.6 MATERIALS

A. Bolts and Nuts:

1. Squarehead bolts and heavy hexagon nuts, ANSI B18.2.1 and B18.2.2, and ASTM A307 or A 576.
2. Bolts, underground, ASTM A 325.

B. Sway Brace: Except for pipes, material shall be structural steel conforming to ASTM A 36. Steel pipes shall conform to ASTM A 501.

C. Flexible Couplings: Flexible couplings shall have same pressure ratings as adjoining pipe. Where required by these specifications, flexible couplings shall be one of the following:

1. Flexible ball joints conforming to the following requirements may be employed on aboveground piping. Joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation plus not less than 15-degree angular movement. Joints shall be certified to be suitable for the service intended by the manufacturer, based on not less than 2 years' satisfactory operation in a similar application.
2. Flexible metal hose type joints may be used for aboveground or underground piping, up to 8" pipe diameter. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

D. Resilient Vibration Isolation Devices:

1. Selection of anchor bolts for vibration isolation devices and/or snubbers to equipment base and foundations shall follow the same procedure as in paragraph "Anchor Bolts".
2. Multidirectional Seismic Snubbers: Multidirectional seismic snubbers employing elastomeric pads shall be installed on all floor or slab-mounted equipment. Snubbers shall provide 0.25 inches vertical and horizontal clearances. Vertical forces shall be resisted by the snubber medium. Provide additional structural steel supports/frame necessary for equipment to insure proper restraint.
3. Seismically Restrained Vibration Isolators: As an option to multidirectional seismic snubbers, a unitized adjustable open spring isolator and a welded steel housing designed to resist seismic forces in all directions may be utilized. Restraint surfaces which engage under seismic motion shall be cushioned with a resilient elastomer, neoprene or equal, to protect equipment.
4. Restraints shall allow a maximum of 1/4" movement before engaging and shall not interfere in normal operation. Housing shall allow for visual inspection of the spring. The entire assembly shall have a certified minimum rating of 1g. in all directions. Submit test data from independent testing lab.
5. Isolator shall be stable spring with a minimum Ky/Ky of 1.0 and the spring shall be isolated from the housing by an internal elastomeric pad on its base for sound absorption. Spring shall have a combination leveling bolt and equipment fastening device. Nuts and bolts shall be zone-electroplated to prevent corrosion. Adjusting bolt and equipment attachment shall have a minimum rating of 1g. Bolting equipment to isolator with bolts smaller than main adjusting bolt will not be allowed.
6. Baseplate shall have adequate means for bolting to the structure. If elastomeric pad for sound absorption is on baseplate of housing, anchor bolts shall be isolated with elastomeric grommets.

2.7 CABLE RESTRAINT

A. Restraint assembly for suspended equipment, piping and ductwork consisting of galvanized steel aircraft cable attached to galvanized steel thimbles or steel assemblies with two clamping bolts. Thimbles or assemblies shall be specifically designed for cable service, shall be able to swivel to final installation angle and shall be securely fastened to the equipment or equipment base and the building structure. Cables shall be sized for the force required per code with a minimum safety factor of 2.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install and anchor seismic-control products according to manufacturer's written instructions and authorities having jurisdiction.

2. Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.
3. Anchor exterior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural supports as required by authorities having jurisdiction.
4. Fill concrete inertia bases, after installing base frame, with 3000-psig concrete, and trowel to a smooth, hard finish.
5. Install pipe connectors at connections for equipment supported on vibration isolators.
6. Install cables to prevent excessive seismic motion and so arranged that they do not engage during normal operation.

B. Sway Braces for Piping, Conduit and Ducts

1. Sway braces shall be installed on piping, conduit and HVAC ducts to preclude damage during seismic activity. Provisions of this paragraph apply to all piping within a 5-foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the same intervals as determined by the smallest diameter pipe of the group. No trapeze-type hanger shall be secured with less than two 1/2 inch bolts. Bracing rigidly attached to pipe flanges, or similar, shall not be used where is would interfere with thermal expansion of piping.
2. Sway Braces for Piping and Conduit:

    a. Horizontal Runs: Provide transverse and longitudinal sway bracing at intervals as required for the pipe size and seismic zone.
    b. Vertical Runs: Vertical runs of piping 1-1/2” or greater diameter shall be braced at not more than 10-foot vertical intervals. For piping smaller than 1-1/2” diameter, bracing shall be provided at no more than 4-foot spacing.
    c. Anchor Rods, Angles, and Bars: Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in place concrete or masonry insert of clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as specified below. Anchor rods, angles, and bars shall not exceed lengths given in Table III.
    d. Clamps: Clamps on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps applied over insulation vapor barrier with high-density inserts and metal protection shields under each clamp.
    e. Bolts: Bolts used for attachment of anchors to pipe and structure shall be not less than 1/2 inch diameter.

3. Sway Braces for HVAC Ducts:

    a. Transverse Sway Bracing: Transverse sway bracing shall be provided at each horizontal turn of 45 degrees or more, at the end of each duct run, and otherwise at intervals as required for duct size and seismic zone. Walls which ducts penetrate may be considered transverse braces.
    b. Longitudinal Sway Bracing: Longitudinal sway bracing shall be provided at intervals as required for duct size and seismic zone. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it, if the bracing is installed within 4 feet of the intersection, and it is sized for the larger duct.

C. Piping and Conduit Penetration Requirements

1. All piping from 1 to 3-1/2 inches diameter shall be installed with 1" clearance on all sides and at every floor, and masonry or concrete wall penetration. A 2" clearance is required for pipe sizes larger than 3-1/2".
2. Insulated and uninsulated pipes and conduit passing through walls and partitions (except smoke and fire walls and partitions) shall be run through not less than No. 12 gauge steel pipe sleeves finishing flush with the finished wall surfaces. Where covered pipes pass

through the walls or partitions, same shall be centered in steel pipe sleeves. All sleeves or thimbles shall be independent of the pipes they enclose and centered in sleeves to insure free movement of the pipes without injury to pipe insulation, wall or other finish. Caulk around all pipes and pipe sleeves passing through walls or ceilings with untarred jute and make airtight and soundproof.

3. Insulated and uninsulated pipes and conduit passing through fire, or fire and smoke walls and partitions shall be run through rated wall sleeve assemblies sealed with Hilti CS-240 firestop sealant or approved equal UL approved sealant meeting the approval of the authority having jurisdiction and as indicated on details on drawings.
4. Pipe sleeves through outside walls shall be Schedule 40 steel pipe sleeves with 1-1/2"collar welded to center of sleeve and cast in wall. Caulk between sleeves and pipes and make watertight.
5. Materials and equipment shall conform to the respective specifications and other requirements specified below:

D. Spreaders

1. Provide spreaders between racked or adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart or four times the maximum displacement due to seismic force. Spreaders to be applied at same interval as sway braces. Spreaders shall be applied to surface of bare or insulated hot pipe and over insulation utilizing high-density inserts and pipe protection shields where vapor-barrier-type insulation is employed.

E. Flexible Couplings or Joints

1. Building Piping: Flexible couplings or joints in building piping shall be provided in the following locations on pipe risers:

   a. Within 24 inches of the top and bottom of all risers. This requirement may be deleted in risers less than 3 ft. in length, and in risers 3 to 7 ft. in length, one flexible coupling is adequate.

2. Underground Piping: All underground piping and 4-inch or larger conduit, except heat distribution system, shall have flexible couplings installed adjacent to building. Additional flexible couplings shall be provided as follows:

   a. On each side of the joints of demarcation between soils having widely differing degrees of consolidation.
   b. At all points that can be considered to act as anchors.
   c. On every branch of a tee and each side of an elbow.

F. Anchor Bolts

1. All floor or pad mounted equipment required by any Section of these specifications shall use cast-in-place or female wedge type anchor bolts. Anchor bolts must conform to ASTM A 307. Female wedge anchors shall have an evaluation report number from ICBA Evaluation Service. Anchor bolts shall have an embedded straight length equal to at least twelve times nominal diameter of the bolt. If the size and number of the anchor bolts are not shown on the drawings, then anchor bolts shall conform to the applicable codes and standards for the various equipment weights or the manufacturer's installation recommendations, whichever is the most stringent.

G. Equipment Sway Bracing

1. Provide for all items supported from overhead floor or roof structures with the following requirements:

    a. Braces shall consist of angles, rods, bars, or pipes secured at both ends with not less than 1/2 inch bolts. Braces shall conform to all applicable codes and standards. Bracing shall be provided in two planes of directions, 90 degrees apart, for each item of equipment. Sufficient braces shall be provided for equipment to resist a horizontal force equal to 50 percent of the weight of equipment without exceeding safe working stress of bracing components. Details of all equipment bracing shall be submitted for approval.
    b. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90 degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are included at a 45 degree angle.

H. Ceiling mounted air terminals or services installed in lay-in ceilings

1. Positively attach to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
2. Terminals or services weighing not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service or to the structure above. These wires may be slack.
3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.

I. Miscellaneous Equipment

1. The following specific items of equipment to be furnished under this contract shall be constructed and assembled so as to be capable of withstanding the horizontal equivalent static force of 0.11 times the operating weight of the equipment, at vertical center of gravity of the equipment without causing permanent deformation, dislocations, separation of components, or other damage, which would render the equipment inoperative for significant periods of time following an earthquake.

    a. Air Handling Units
    b. Free Standing Electric Motors

J. Floor Mounted Equipment Support

1. Vibration Isolation Bases: Mount equipment on structural-steel bases or concrete inertia bases.
2. Snubbers: Install the required number of seismic snubbers on each spring-mounted piece of equipment. Locate snubbers as close as possible to the vibration isolators and bolt to supporting structure.

3.2 ADJUSTING AND CLEANING

A. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operations.

B. Adjust thrust restraints for a maximum of 1/4 inch of movement at start and stop.

3.3 SPECIAL INSPECTION

A. Special Inspector: Employ a factory trained representative during construction to observe the work specified and to ensure that it conforms to the Contract documents. Factory trained representative shall be a qualified person who shall demonstrate competence and specialized experience, to the satisfaction of the engineer of record, for inspection of the seismic protection of mechanical and electrical equipment.

B. Inspection Requirements: The factory trained representative shall periodically inspect the following systems to verify conformance with the contract documents and the local code:

1. Installation of piping systems intended to carry flammable, combustible or highly toxic contents and their associated mechanical units in structures assigned to Seismic Design Category C, D, E or F.
2. Installation of HVAC ductwork that will contain hazardous materials in structures assigned to Seismic Design Category C, D, E or F.
3. Installation of vibration isolation systems in structures assigned to Seismic Design Category C, D, E or F where a nominal clearance of 0.25 inches or less between the equipment support frame and restraint is required.

C. Inspection Reports: Ensure that the inspection report is furnished from the special inspector to the engineer of record. At the end of the work, ensure that a final, signed report is submitted by the special inspector, stating whether the work requiring special inspection was, to the best of the special inspector’s knowledge, in conformance with the Contract documents.

D. Discrepancies: Discrepancies shall be brought to the immediate attention of the Contractor for correction, and then, if uncorrected, to the architect and engineer of record.

END OF SECTION 200548

SECTION 220010 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 22 of the Specifications and Drawings numbered with prefixes P, MP and EP generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer’s requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code – 2018
IMC	International Mechanical Code – 2018
IPC	International Plumbing Code – 2018
IFGC	International Fuel Gas Code – 2018
IECC	International Energy Conservation Code – 2018
ADA	American Disabilities Act
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer’s Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: The term “furnish” is used to mean “supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations.”
2. Install: The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”

3. Provide: The term “provide” means “to furnish and install, complete and ready for the intended use.”
4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.
6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. CMATT: Certified Acceptance Mechanical Test Technician. A professional certified to perform acceptance tests and complete the documentation required for nonresidential acceptance tests as required by the California Building Energy Efficiency Standards. Technician shall be certified by an authorized mechanical acceptance test technician certification provider.
8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
    b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

10. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
2. Bedding: as used in this Section refers to the compacted sand or pea gravel installed in the bottom of a pipe trench to immediately support a pipe and cover a pipe.
3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

A. Refer to Division 1 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples and other submittals required by this Division as noted in Table 1 at the end of this Section. Provide the number of submittals required by Division 1; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

F. Refer to individual Sections for additional submittal requirements.

G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before Plumbing construction starts.

H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

I. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

J. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the

submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

K. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

L. Provide welders' qualification certificates.

M. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer

1.8 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

    a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
    d. Same warranty will be furnished for proposed substitution as for specified Work.
    e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer’s review, and for the Owner’s use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in Table 2.

F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer’s designated representatives.

1.10 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.11 TRAINING/DEMONSTRATION

A. Provide general training and equipment demonstration to Owners representative. This shall include, but is not limited major component location and basic equipment operation. The Owners representative should be aware of the basic building systems and their operation.

1.12 PAINTING

A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Plumbing Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.13 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.14 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.
2. Insulation shall be effective.

3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.15 TEMPORARY FACILITIES

A. Refer to Division 1 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Water: Premises are supplied with water services which may be used in this work: Contractor shall make his own arrangements for water services.
2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, nonclogged condition during construction period.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

D. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting His bid to determine the nature and extent of work involved.
2. Work in the existing building shall be scheduled with the Owner.
3. Certain demolition work must be performed prior to the remodeling. The Plumbing Contractor shall perform the demolition which involves Plumbing and Plumbing systems, fixtures, equipment, piping, equipment supports or foundations and materials.
4. Plumbing Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Plumbing Contractor during this demolition shall become his property and shall be removed by the Plumbing Contractor from the premises and dispose of them in accordance with applicable federal, state and local regulations.
5. Plumbing Contractor shall relocate and reconnect Plumbing facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Plumbing equipment or materials are removed, the Plumbing

Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.

6. General Contractor shall install finish material.
7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
9. Locate, identify, and protect Plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

E. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

F. Use of explosives is not permitted.

G. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 SOIL MATERIALS

A. Provide clean sand, pea gravel or flowable fill material (per the geotechnical engineer’s or structural engineer’s recommendations).

B. Subbase Material: Where applicable, provide natural soils with 10% by volume of rocks less than 2” diameter or artificially crushed aggregate. Corrosive fill materials shall not be utilized. When CL clay, rock, or gravel is used, it shall not be larger than 2 inches in any dimension and be free of debris, waste, frozen materials, vegetable and other deleterious matter.

C. Filter Fabric: Flat needle punched PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4,480 to 13,440 L/min. per sq. m) when tested according to ASTM D 4491.

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.3 SELECTIVE DEMOLITION

A. Refer to Division 01, Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein

B. General: Demolish, remove, demount, and disconnect abandoned Plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

D. Plumbing Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, controls, fixtures and insulation.

    a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
    b. Perform cutting and patching required for demolition in accordance with Division 1, General Conditions and "Cutting and Patching" portion of this Section in Division 22.

3.4 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.

C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.

D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

E. Erect barricades around excavations. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.

F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.

1. Do not allow water to accumulate in excavations and trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Tanks, Basins, and Plumbing Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for Plumbing installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.
2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.
5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

N. Bedding:

1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below:
2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.

O. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
2. Under building slabs, use drainage fill materials.
3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support after installation and testing of piping and prior to backfilling and placement of roadway subbase. Coordinate with AHJ for colored concrete requirements.
5. Other areas, use excavated or borrowed materials.

P. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.
2. Removal of concrete formwork.
3. Removal of shoring and bracing, and backfilling of voids.
4. Removal of trash and debris.

Q. Placement and Compaction: Place subgrade backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

R. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

S. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

T. Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Use of pneumatic backhoe as compaction method is not allowed as an acceptable process for compaction of excavations or trenches.
2. For vertical and/or diagonal pipe installations greater than ½" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.
3. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.
5. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

    a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

U. Subsidence: Where subsidence occurs at Plumbing installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

V. Additional Excavation: Where additional excavation may be required due to unsuitable bearing materials encountered, notify the architect immediately for resolution.

3.5 CUTTING AND PATCHING

A. The Contractor shall do necessary cutting of walls, floors, ceilings and roofs.

B. No structural member shall be cut without permission from Architect.

C. Patch around openings to match adjacent construction.

D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.6 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.7 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 22 that contain special inspection requirements.
4. Start-up testing of systems.
5. Removal of temporary facilities from the site.
6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

TABLE 1: PLUMBING SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220010	General Plumbing Requirements	NONE
220015	Coordination	NONE
220500	Common Work Results For Plumbing	A, B, G, M
220513	Common Motor Requirements For Plumbing Equipment	B
220515	Basic Piping Materials And Methods	B, G
220516	Expansion Fittings and Loops for Plumbing Piping	B, G
220519	Meters And Gauges For Plumbing Piping	B, H
220523	General-Duty Valves For Plumbing Piping	B
220529	Hangers And Supports For Plumbing Piping	B, F, G, H
220548	Seismic Controls For Plumbing Piping & Equipment	A, B, C, D, I, M
220550	Vibration Isolation For Plumbing Piping & Equipment	A, B, C, F, I, J
220553	Identification For Plumbing Piping & Equipment	B, L, M
220700	Plumbing Insulation	B, M
221100	Water Distribution Piping & Specialties	B, G, H
221111	Mechanically Joined Plumbing Piping Systems	B, G, H
221112	PEX Tubing Water Distribution System & Specialties	B, G, H
221115	CPVC Water Distribution Systems & Specialties	B, G, H
221123	Domestic Water Pumps	A, B, C, E
221300	Sanitary Drainage & Vent Piping & Specialties	B
221328	Condensate Pumps for HVAC Equipment	A, B, C, E
221400	Storm Drainage Piping & Specialties	B
223300	Electric Domestic Water Heaters	B, C, E, F, H, K
224000	Plumbing Fixtures	B, E, N

CODED LEGEND

A	Shop Drawings
B	Product Data and equipment weights
C	Performance Data, Curves, Certificates and Test Data
D	Coordination Drawings
E	Wiring Diagrams and short circuit current ratings
F	Installation Instructions
G	Welder’s Certificates
H	Certificates
I	Calculations
J	Special Inspections
K	Special Warranties
L	Material Samples
M	Schedules

TABLE 2: SPECIAL INSPECTION REQUIREMENTS FOR PLUMBING EQUIPMENT

SECTION NUMBER		COMPLETED/DATE/INITIAL
220548	Seismic Controls For Plumbing Piping & Equipment	_____
220550	Vibration Isolation For Plumbing Piping & Equipment	_____

TABLE 3: PLUMBING SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220500	Common Work Results For Plumbing	B
220513	Common Motor Requirements For Plumbing Equipment	B
220515	Basic Piping Materials And Methods	B
220516	Expansion Fittings And Loops For Plumbing Piping	A, B
220519	Meters And Gauges For Plumbing Piping	B, G, I
220523	General-Duty Valves For Plumbing Piping	B, H, I
220529	Hangers And Supports For Plumbing Piping	B
220548	Seismic Controls For Plumbing Systems	A, B, C
220550	Vibration Isolation For Plumbing Piping & Equipment	A, B, C
220553	Identification For Plumbing Piping & Equipment	B
220700	Plumbing Insulation	B
221100	Water Distribution Piping & Specialties	A, B, F, H, I
221111	Mechanically Joined Plumbing Piping Systems	A, B, F, H, I
221112	PEX Tubing Water Distribution System & Specialties	A, B, F, H, I
221115	CPVC Water Distribution Systems & Specialties	A, B, F, H, I
221123	Domestic Water Pumps	B, C, D, E, G, H, I
221300	Sanitary Drainage & Vent Piping & Specialties	A, B, F
221328	Condensate Pumps for HVAC Equipment	B, C, D, E, G, H, I
221400	Storm Drainage Piping & Specialties	A, B, F, H, I
223300	Electric Domestic Water Heaters	B, C, D, E, G, H, I
224000	Plumbing Fixtures	B, E, H, I

CODED LEGEND

A	As-Built Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Wiring Diagrams
E	Operating Instructions
F	Test Reports
G	Warranties
H	Recommended Spare Parts List
I	Service and Maintenance Instructions

END OF SECTION 220010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

SECTION 220015 - COORDINATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Plumbing Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Plumbing Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections

C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV 22	DIV 22	DIV 26	---
Factory furnished motor starters, contactors and disconnects	DIV 22	DIV 26	DIV 26	DIV 23
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV 26	DIV 26	DIV 26	DIV 23
Factory assembled control panels	DIV 22	DIV 26	DIV 26	DIV 23
Control relays and transformers	DIV 22	DIV 22	DIV 26	DIV 23
Thermostats (line voltage)	DIV 22	DIV 22	DIV 26	---
Time switches	DIV 22	DIV 22	DIV 26	DIV 23
Remote pressure switches (booster pumps)	DIV 22	DIV 22	---	DIV 23
Temperature control panels	DIV 22	DIV 22	DIV 26	DIV 23
Variable speed drives	DIV 22	DIV 22	DIV 26	DIV 23
Motor and solenoid operated valves	DIV 22	DIV 22	DIV 23	DIV 23

DIV 22 = Plumbing Contractor
DIV 26 = Electrical Contractor
DIV 23 = Building Automation System Contractor, refer to Division 23 Section ”Direct-Digital Control for HVAC”.

END OF SECTION 220015

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SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:

1. Access panels and doors in walls, ceilings, and floors for access to Plumbing materials and equipment.
2. Plumbing equipment nameplate data.
3. Concrete for bases and housekeeping pads.
4. Non-shrink grout for equipment installations.
5. Sleeves for Plumbing penetrations.
6. Miscellaneous metals for support of Plumbing materials and equipment.
7. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.
8. Joint sealers for sealing around Plumbing materials and equipment.
9. Plenum insulation for enclosure of combustible items located within fire-rated return air plenums.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section “Penetration Firestopping” for material and methods for firestopping systems.
2. Division 22 Section "Basic piping Materials and Methods" for materials and methods for mechanical sleeve seals.
3. Division 23 Section “Instrumentation and Control for HVAC” for integration with building automation system of leak detection system “Water Present” alarm.
4. Division 22 Section “Sanitary Drainage and Vent Piping and Specialties” for indirect drain piping and installation requirements.
5. Division 26 Section “Common Work Results for Electrical” required electrical devices.
6. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 1 and Division 22 Section “General Plumbing Requirements”.

1. Product data for the following products:

a. Access panels and doors.
b. Through and membrane-penetration firestopping systems.
c. Joint sealers.

2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.
3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."

5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturer:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section “Identification for Plumbing Piping” for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 24 inches x 24 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Architect prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

    a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
    b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
    c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

    a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

8. Locking Devices: Flush, screwdriver-operated cam locks.

2.2 PLUMBING EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated Plumbing equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS

A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted Plumbing equipment.. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.

B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.

C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the latest applicable recommendations of the ACI standard practice manual. Concrete shall be composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.

D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x W2.9

welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24" on center with a minimum of two bars each direction.

E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.

F. Concrete equipment bases and housekeeping pads shall have minimum heights in accordance with the following table:

Equipment	Minimum Height
Water Heaters, Water Softeners and Equipment Less than or equal to 20 tons and Other Equipment Not Listed – Note 1	3-1/2"

NOTES:

1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.

2.4 GROUT

A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.

B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.

C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.5 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.6 DRIP PANS

A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2” lapped and soldered joints. Drip pan shall have a depth of 2” and a width of 6” in addition to the diameter of the associated pipe. Provide 3/4” galvanized pipe with male NPT outlet at low point of drip pan.

B. Drip pan supports shall be ¼” X 2” galvanized bar stock welded to the drip pan without holes.

2.7 LEAK DETECTION SYSTEM

A. Leak detection system with Rope style leak sensor and controller capable of connecting to a building automation system with audible and visual alarms for leak detection and cable failure in all drip pans unless otherwise noted on drawings. Provide with factory 24V DC power supply with power plug, sensing cables, and accessories.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. RLE Technologies #LD1000

2.8 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.9 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less that 15/32 inches.

2.10 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Elastomeric Joint Sealers: Provide the following types:

1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

a. "Dow Corning 790," Dow Corning Corp.
b. "Silglaze II SCS 2801," General Electric Co.
c. "Silpruf SCS 2000," General Electric Co.
d. "864," Pecora Corp.
e. "Rhodia 5C," Rhone-Poulenc, Inc.
f. "Spectrem 1," Tremco, Inc.
g. "Spectrem 2," Tremco, Inc.
h. "Dow Corning 795," Dow Corning Corp.
i. "Rhodia 7B," Rhone-Poulenc, Inc.
j. "Rhodia 7S," Rhone-Poulenc, Inc.
k. "Omniseal," Sonneborn Building Products Div.

2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

a. "Dow Corning 786," Dow Corning Corp.
b. "Sanitary 1700," General Electric Co.
c. "898 Silicone Sanitary Sealant," Pecora Corp.

D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:

1. Products: Subject to compliance with requirements, provide one of the following:

a. "Chem-Calk 600," Bostik Construction Products Div.
b. "AC-20," Pecora Corp.
c. "Sonolac," Sonneborn Building Products Div.
d. "Tremflex 834," Tremco, Inc.

2.11 PLENUM INSULATION

A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated return air plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.

B. Material: FyreWrap 0.5 Plenum Insulation, ETS Schaefer Plenumshield Blanket, or equivalent utilizing light weight, high temperature blanket enhanced for biosolubility. The encapsulating material shall be aluminum foil with fiberglass reinforcing scrim covering.

C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.

D. Physical Properties: Plenum insulation shall be single ½” layer with a density of 6 to 8 pounds per cubic foot.

2.12 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:

1. 3M Corp., Fire Barrier Sealant
2. Hilti
3. Owens Corning, Firestopping Insulation.
4. Pecora, AC-20 FTR
5. RectorSeal
6. Specified Technologies Inc.,
7. United States Gypsum Company
8. 3M Corp.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install leak detection systems, plenum insulation, access doors and sealants in accordance with manufacturer’s installation instructions.

3.2 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.5 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.6 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.7 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors 2 inches above finished floor level.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

K. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section “Basic Piping Materials and Methods”.

3.8 DRIP PANS

A. Provide drip pans in locations indicated on drawings.

B. Provide drip pans for piping directly above a two hour rated ceiling of an elevator machine room.

C. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.

D. Provide drip pan supports every 4’-0”. Provide ¼” galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.

E. Connect ¾” type “L” copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.

F. Install leak detection rope in a zig-zag pattern covering entire length and width of the drip pan. Secure rope to pan per manufacturers recommendations.

G. Mount leak detection controller on wall adjacent to exit of the room above which the drip pan is located unless otherwise indicated on drawings indicated on drawings.

H. Coordinate disconnect and power supply for leak detection system and 120V dedicated receptacle adjacent to controller with Division 26. Power wiring and receptacles are specified in Division 26 Section “Common Work Results for Electrical” Disconnects are specified in Division 26 Section “Enclosed Switches and Circuit Breakers”

I. Coordinate interlock of “Water Present” alarm and “Cable Fault alarm with Building Automation System. Refer to Division 23 Section “Instrumentation and Control for HVAC” for integration with building automation system and low voltage power wiring.

3.9 PLENUM INSULATION

A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated return air plenums where permitted by the local authority having jurisdiction

B. Overlap: Provide a minimum 1” perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.

C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer’s written installation instructions.

D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated return air plenums where the use of plenum insulation is not approved.

END OF SECTION 220500

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SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following:

1. Single phase electric motors.
2. Three phase electric motors.

1.2 SUBMITTALS

A. General: Submit the following in accordance with conditions of contract and Division 1 specification Sections.

1. Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.3 QUALITY ASSURANCE

A. All motors shall be UL listed.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Century

B. General Electric

C. Westinghouse

D. Baldor

E. Gould

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors Less Than 250 Watts, for Intermittent Service: Provide equipment manufacturer's standard. Motor's need not conform to these specifications.

B. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.

1. Motors 3/4 HP and Larger: 480 volts, three phase, 60 Hz.
2. Motors 1/2 HP and Smaller: 120 volts, single phase, 60 Hz.

C. Type:

1. Open drip-proof except where noted otherwise.
2. Motors: Design for continuous operation in 40 degrees C environment.

3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. Motors with frame sizes 254T and larger: Energy Efficient Type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.3 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.4 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Drip-proof Enclosure: NEMA Service Factor.

G. All motors controlled by variable frequency controllers shall have a 1.15 Service Factor.

H. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

I. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

J. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Division 16 - Motor Controlling Equipment.

K. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: To NEMA MG 1.

M. All totally enclosed motors shall be fan cooled type. Non-ventilated type motors are not acceptable.

N. Variable Frequency Drive Motors: Motors controlled by variable frequency drives shall be rated for voltage peaks and minimum rise times in accordance with NEMA MG1, Part 31.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Inverter-Duty Motors: Class B temperature rise; Class F insulation.
3. Grounding: Provide shaft grounding system equal to AEGIS SGR Bearing Protection Ring, Inpro/Seal Current Diverter Ring (CDR) or approved equal. Install system in accordance with manufacturer’s recommendations.

O. Nominal Efficiency: Motors shall have minimum efficiency meeting the requirements of the Energy Policy Act of 1992 and as scheduled at full load and rated voltage when tested in accordance with IEEE 112.

P. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.5 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 22 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.
2. All welded steel housing.
3. Each capacitor internally fused.
4. Non-flammable synthetic liquid impregnated.
5. Craft tissue insulation.
6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 APPLICATION

A. Single phase motors for pumps and air compressors: Capacitor start type.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.

3.3 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.4 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86.5	86
5	1800	184T	87.5	87
7-1/2	1800	213T	88.5	86
10	1800	215T	89.5	85
15	1800	256T	91	85
20	1800	256T	91	86
25	1800	284T	91.7	85
30	1800	286T	92.4	88
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	88
75	1800	365T	94.1	88
100	1800	404T	94.1	83
125	1800	405T	94.5	86
150	1800	444T	95	85
200	1800	445T	95	85
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	145T	84	85
5	3600	182T	85.5	86
7-1/2	3600	184T	87.5	88
10	3600	213T	88.5	86
15	3600	215T	89.5	89

20	3600	254T	90.2	89
25	3600	256T	91	92
30	3600	284T	91	91
40	3600	286T	91.7	92
50	3600	324T	92.4	89
60	3600	326T	93	91
75	3600	364T	93	88
100	3600	365T	93	88

3.5 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	87.5	83
5	1800	184T	87.5	83
7-1/2	1800	213T	89.5	85
10	1800	215T	89.5	84
15	1800	254T	91	86
20	1800	256T	91	85
25	1800	284T	92.4	84
30	1800	286T	92.4	86
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	87
75	1800	365T	94.1	87
100	1800	405T	94.5	86
125	1800	444T	94.5	87
150	1800	445T	95	88
200	1800	447T	95	87
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	182T	85.5	87
5	3600	184T	87.5	88
7-1/2	3600	213T	88.5	86
10	3600	215T	89.5	86
15	3600	254T	90.2	91

20	3600	256T	90.2	89
25	3600	284T	91	92
30	3600	286T	91	92
40	3600	324T	91.7	91
50	3600	326T	92.4	92
60	3600	364T	93	93
75	3600	365T	93	91
100	3600	405T	93.6	92

END OF SECTION 220513

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SECTION 220515 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Common Work Results for Plumbing," for materials and methods for sleeve materials.

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. Refer to Division 1 and Division 22 Section “General Plumbing Requirements” for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:

1. Escutcheons
2. Dielectric Unions
3. Dielectric Waterway Fittings
4. Dielectric Flanges and Flange Kits
5. Mechanical Sleeve Seals
6. Wall Pipes
7. Strainers
8. Flexible Connectors

C. Quality Control Submittals:

1. Submit welders' certificates specified in Quality Assurance below.

D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.4 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.

C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.

D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:

1. Pipe Escutcheons:

a. AWI Manufacturing.
b. Keeney Manufacturing Company
c. Wal-Rich Corp.
d. Jones Stephens Corp.

2. Dielectric Unions:

a. JOMAR International
b. Smith Cooper International
c. Watts Regulator Co.
d. Zurn Industries

3. Dielectric Flanges and Flange Kits:

a. Calpico, Inc.
b. FMC Technologies
c. Pipeline Seal & Insulator, Inc.
d. Tampa Rubber and Gasket Co., inc.
e. Watts Industries Inc.; Water Products Div.
f. Zurn Industries, Inc.; Wilkins Div.

4. Strainers:

a. Armstrong Machine Works.
b. Hoffman Specialty ITT; Fluid Handling Div.
c. MEPCO
d. Metraflex Co.
e. Mueller Steam Specialties.

f. Nicholson Steam
g. RP&C Valve, Division of Conbraco Ind.
h. Spirax Sarco.
i. Watts Regulator Co.

5. Mechanical Sleeve Seals:

a. Advance Products & Systems
b. Calpico, Inc.
c. GPT Industries/Link Seal
d. Metraflex Co.
e. Proco Products, Inc.

6. Metal Flexible Connectors:

a. U.S. Hose, Corp.
b. Hyspan
c. Mason Industries, Inc.
d. Mercer Rubber Co.
e. Metraflex Co.
f. Proco Products, Inc.
g. Resistoflex
h. Tyler Pipe; Gustin-Bacon Div.

7. Rubber Flexible Connectors:

a. General Rubber Corp.
b. Mason Industries, Inc.
c. Mercer Rubber Co.
d. Metraflex Co.
e. Proco Products, Inc.
f. Uniflex, Inc.

8. Wall Pipes

a. Josam Mfg. Co.
b. Smith (Jay R) Mfg. Co.
c. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
d. Watts Industries, Inc.
e. Zurn Industries, Inc.; Hydromechanics Div.

2.2 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.

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. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

E. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions:

1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.

C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Dielectric Flanges and Flange Kits:

1. Full faced gasket with same outside diameter and bolt hole arrangement as the flange. Pressure rating of 200psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.
2. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.
3. Lead free cast bronze meeting ASTM B584, class 125 solder type or cast iron class 125 threaded type for low pressure service and bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

E. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens for 4” and smaller shall be Type 304 stainless steel mesh with 0.062” perforations and screens for 5” and larger shall be Type 304 stainless steel, with 0.125" perforations.

1. For low pressure applications, cast iron strainers shall have 125 psi working pressure rating and cast bronze strainers shall have 150 psi working pressure rating. For high pressure applications, cast iron strainers shall have 250 psi working pressure rating and cast bronze strainers shall have 300 psi working pressure rating.
2. Solder Ends, 2” and Smaller: Lead free cast bronze body meeting ASTM B584, screwed screen retainer with centered blowdown fitted with pipe plug.

3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

F. Sleeves:

1. Sleeve: Refer to Division 22 Section “Common Work Results for Plumbing” for sleeve materials.

G. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

H. Flexible Connectors: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections.

1. Bronze Hose, Flexible Connectors: For 2” and smaller, corrugated bronze inner tubing covered with bronze wire braid. Include ANSI 150# brass nipples with screwed connections, braised to hose.
2. Stainless-Steel-Hose, Flexible Connectors: For 2-1/2” and larger, corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include ANSI 150# 304 stainless-steel nipples or flanges, welded to hose.

2.5 WALL PIPES

A. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.6 WALL SLEEVES

1. Steel sleeve of schedule 40 pipe meeting ASTM A53B with 2” wide metal plate meeting ASTM A36 welded all around. Hot dip galvanized inside and out.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s installation instructions.

3.2 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.3 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other

design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.

C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

I. Verify final equipment locations for roughing in.

3.4 PIPING PROTECTION

A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.5 PENETRATIONS

A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

B. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

C. Underground, Exterior-Wall Penetrations: Provide galvanized steel wall sleeve. Wall sleeve is not required for existing concrete walls with core drilled penetrations. Size wall sleeves to allow for 1-inch or larger, if required by the mechanical sleeve seal manufacturer) annular clear space between pipe and sleeve. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer 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.
2. Verify sleeve and mechanical sleeve seal installations for damage and faulty work. Verify watertight integrity of sleeves and mechanical sleeve seals installed below grade to seal against hydrostatic water pressure. If sleeve and or sleeve seal are not watertight, provide new wall sleeve and mechanical sleeve seal.

D. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum ½" annular space between pipe and wall pipe.
2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
3. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."
5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

E. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.

F. Concrete Slab on Grade Penetrations:

1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.
2. Provide ½" thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2" above and below the concrete slab.

G. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

H. Exterior Wall Penetrations: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

I. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.

3.6 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install components with pressure rating equal to or greater than system operating pressure.

D. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, mixing valve, backflow preventer and elsewhere as indicated.

E. Install unions at the final connection to each piece of equipment adjacent to each isolation valve or valve assembly for connections 2" and smaller. Install unions where indicated elsewhere on the drawings.

F. Install flanges at the final connection to each piece of equipment, adjacent to each isolation valve or valve assembly in piping 2-1/2" and larger. Install flanges at each valve 2-1/2" and larger.

G. Install dielectric unions for piping 2" and smaller or dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for copper or brass connected to carbon steel, cast or ductile iron.

H. Install dielectric unions for piping 2" and smaller or dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.

I. Install dielectric flanges for piping 2-1/2" and larger for copper or brass pipe connections to carbon steel equipment connections, steel, ductile iron or cast iron valves and fittings.

J. Dielectric Flange Installation:

1. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.
2. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.
3. Provide full face gasket with pressure rating equal to system served.
4. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.7 JOINTS

A. Steel Pipe Joints:

1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
2. Pipe Larger Than 2":

a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.
2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.8 FLEXIBLE CONNECTORS

A. Install flexible connectors for piping system connections on equipment side of shutoff valves for all Plumbing equipment, pumps, and where indicated on Drawings.

1. Install stainless steel connectors for domestic water copper equipment connections 2” and smaller.
2. Install bronze connectors for non-domestic water copper equipment connections 2” and smaller.
3. Install flanged stainless steel connectors for flanged equipment connections 2-1/2” and larger.

B. Install connectors according to manufacturer’s recommendations.

END OF SECTION 220515

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SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following:

1. Packless expansion joints

1.2 DEFINITIONS

A. Pipe sizes used in this Specification are nominal pipe size (NPS).

B. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

1. Product data for each type of pipe expansion joints specified. Submit expansion compensation schedule showing manufacturer's figure number, size, location, connections, material and displacement for each required expansion joint.
2. Maintenance data for expansion joints for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."
3. Submit certification that expansion joints for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372.
4. Submit American Gas Association certification for expansion joints used for natural gas distribution systems.
5. Submit certification that expansion joints are listed for the Uniform Plumbing Code (UPC).

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following codes:

1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.

B. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

C. Expansion joints shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Packless Expansion Compensators:
   a. Adsco Manufacturing Corp.
   b. Anamet, Inc.
   c. Flexonics Inc., Metal Hose and Expansion Joint Div.
   d. Hyspan Precision Products, Inc.

e. Keflex HVAC Products, Flex-Weld, Inc.

f. Metraflex Co.

2.2 PIPE EXPANSION JOINTS, GENERAL

A. Pipe expansion joints shall provide 200 percent absorption capacity of piping expansion between anchors.

B. Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

C. Fittings: Materials of construction and end fitting type shall be consistent with pipe material and equipment / pipe connection fittings. Copper fittings shall not be attached to stainless steel hose.

2.3 PACKLESS EXPANSION JOINTS

A. Expansion Compensators for domestic distribution water systems: Flexible loops shall consist of two 90 degree elbow and one 180 degree return assembly, such that the piping does not change direction and maintains course along a single axis. Provide with support nut at the bottom of the 180 degree return assembly for proper positioning, drain plug, lead free internal bronze flexible braid with brass shroud and copper elbows. Provide copper sweat ends for 2” and smaller and lead free bronze 150# flanges for 2-1/2” and larger. Units shall be cold working pressure 175 psi. Expansion compensators shall have internal guides and antitorque device.

B. Expansion Compensators for natural gas distribution systems: Flexible loops shall consist of two 90 degree elbow and one 180 degree return assembly, such that the piping does not change direction and maintains course along a single axis. Provide with support nut at the bottom of the 180 degree return assembly for proper positioning, drain plug, internal 304 stainless steel braid and steel elbows. Provide screwed ends for 2” and smaller and steel 150# flanges for 2-1/2” and larger. Units shall be cold working pressure 175 psi. Expansion compensators shall have internal guides and antitorque device and bear the AGA stamp.

C. Expansion Compensators for steel pressure or sanitary vent systems: Flexible loops shall consist of two 90 degree elbow and one 180 degree return assembly, such that the piping does not change direction and maintains course along a single axis. Provide with support nut at the bottom of the 180 degree return assembly for proper positioning, drain plug, internal 304 stainless steel braid and steel elbows. Provide screwed ends for 2” and smaller and steel 150# flanges for 2-1/2” and larger. Units shall be cold working pressure 175 psi.Rubber Expansion Joints: Fabric-reinforced butyl rubber with full-faced integral flanges, external control rods and shall be internally reinforced with steel retaining rings over entire surface of flanges, drilled to match flange bolt holes.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install expansion joints and expansion loops where indicated and required for adequate expansion of installed piping system.

B. Anchor piping to ensure proper direction of expansion and contraction

3.2 EXPANSION JOINTS

A. Install expansion joints in accordance with manufacturer's instructions.

B. Align joints to avoid end loading and torsional stress.

3.3 EXPANSION COMPENSATION FOR RISERS AND TERMINALS

A. Install connection between piping mains and risers with at least 5 pipe fittings including tee in main. Install connections between piping risers and terminal units with at least 4 pipe fittings including tee in riser.

END OF SECTION 220516

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SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of meters and gauges:

1. Temperature gauges and fittings.
2. Pressure gauges and fittings.

1.2 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
2. Product certificates signed by manufacturers of meters and gauges certifying accuracy under specified operating conditions and products' compliance with specified requirements.
3. Maintenance data for each type of meter and gauge for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Glass Tube Industrial Thermometers:

a. H. O. Trerice Co.
b. Marshalltown Instruments, Inc.
c. Miljoco Corporation
d. Weiss Instruments, Inc.
e. Weksler Instruments Corp.
f. Winters Instruments

2. Thermometer Wells: Same as for thermometers.
3. Pressure Gauges:

a. Ametek, U.S. Gauge Div.
b. Ashcroft Dresser Industries Instrument Div.
c. Ernst Gage Co.
d. H. O. Trerice Co.
e. Marsh Instrument Co., Unit of General Signal.
f. Marshalltown Instruments, Inc.
g. Miljoco Corporation
h. Weiss Instruments, Inc.

i. Weksler Instruments Corp.
j. WIKA Instruments Corp.
k. Winters Instruments

4. Pressure Gauge Accessories: Same manufacturers as for pressure gauges.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

B. Scale range: Temperature ranges for services listed as follows:

1. Domestic Hot Water: 30 to 240 deg with 2-degree scale divisions (0 to 115 deg C with 1-degree scale divisions).
2. Domestic Cold Water: 0 to 100 deg F with 2-degree scale divisions (minus 18 to 38 deg C with 1-degree scale divisions).

2.3 GLASS TUBE INDUSTRIAL THERMOMETERS

A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Non-red color reading, non-toxic organic spirit-filled glass tube, magnifying lens.

D. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.4 THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.5 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection.

B. Case: Cast aluminum or stainless steel case, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. All fluids: 2 times operating pressure.

G. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

2.6 PRESSURE GAUGE ACCESSORIES

A. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

PART 3 - EXECUTION

3.1 THERMOMETERS INSTALLATION

A. Install in the following locations and elsewhere as indicated:

1. At outlet of each domestic water heater.

B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install in the following locations, and elsewhere as indicated:

1. Provide liquid-filled gauge at suction and discharge of booster pump.
2. At discharge of each pressure-reducing valve.
3. At building water service entrance.

B. Pressure Gauge Needle Valves: Install in piping tee with snubber.

END OF SECTION 220519

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SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes general duty valves common to most mechanical piping systems.

1. Special purpose valves are specified in individual piping system specifications.

B. Contractors Option:

1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined plumbing piping systems to connect plumbing piping where used shall be provided in compliance with specification Section 221111 “Mechanically Joined Plumbing Piping Systems”.

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

B. Submit certification that valves for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Provide products specified in this section from the same manufacturer where products are available and conform to the specification requirements.

B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the MSS Standard Practices below:

1. MSS SP 67 “Butterfly Valves”
2. MSS SP 70 “Gray Iron Gate Valves, Flanged and Threaded Ends”
3. MSS SP 71 “Gray Iron Swing Check Valves, Flanged and Threaded Ends”
4. MSS SP 72 “Ball Valves with Flanged or Butt Welding Ends”
5. MSS SP 80 “Bronze Gate, Globe, Angle and Check Valves”
6. MSS SP 85 “Gray Iron Globe and Angle Valves, Flanged and Threaded Ends”

7. MSS SP 110 “Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends”
8. MSS SP 125 “Check Valves: Gray Iron and Ductile Iron, In-Line, Spring Loaded, Center-Guided”
9. MSS SP 139 “Copper Alloy Gate, Globe, Angle and Check Valves for Low Pressure/Low Temperature Plumbing Applications”

D. Valves shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves containing no more than 0.25% lead by weight compliance for valves for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed in valve schedule.

2.2 VALVE FEATURES, GENERAL

A. Valve Design: Rising stem or rising outside screw and yoke stems.

1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Provide the following special operator features:

1. Handwheels, fastened to valve stem, for valves other than quarter turn.
2. Lever handles, on quarter-turn valves 6-inch and smaller.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. End Connections: As indicated in the valve specifications.

1. Threads: Comply with ANSI B1.20.1.
2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
3. Solder-Joint: Comply with ANSI B16.18.

a. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.3 GATE VALVES

A. Gate Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body, solid wedge and bonnet of ASTM B 584 lead free cast bronze; brass packing gland and stem of ASTM

B283 naval brass; with solder ends, non-asbestos composition packing, and malleable iron handwheel.

B. Gate Valves, 2-1/2-Inch and Larger: Meeting MSS SP-70 and lead free; Class 125, 200-psi CWP, iron body, lead free bronze mounted, with body and bonnet conforming to ASTM A 126 Class B; with lead free brass or steel stem, with flanged ends, non-asbestos composition packing, and two-piece packing gland assembly.

2.4 BALL VALVES

A. Ball Valves, 2 Inch and Smaller: Meeting MSS SP 110, Class150, 600-psi CWP; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof stem and chrome-plated lead free brass ball, with replaceable "Teflon" or "TFE" seats and seals, solder ends and vinyl-covered steel handle.

B. Cast Iron Body Ball Valves, 2-1/2” and larger: Meeting MSS SP 72, 200 CWP, lead free, maximum operating temperature of 140F; two piece cast iron body meeting ASTM A126 Class B with flanged ends, 304 stainless steel full port ball and shaft, ductile iron handle, FDA epoxy coating, PTFE gasket, stem seal and seat.

2.5 CHECK VALVES

A. Swing Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body and cap of ASTM B 584 cast lead free bronze; with horizontal swing, Y-pattern, disc and disc holder of ASTM B 283 alloy C46400 naval brass; solder ends. Provide valves capable of being reground while the valve remains in the line.

B. Swing Check Valves, 2-1/2-Inch and Larger: Meeting MSS SP-71 and lead free; Class 125 200-psi CWP, cast iron body and bolted cap conforming to ASTM A 126, Class B; with horizontal swing, lead free bronze disc with lead free bronze disc face ring, and bronze seat ring; and flanged ends. Provide valves capable of being refitted while the valve remains in the line.

C. Wafer Check Valves: Meeting MSS SP 125, Class 125, 200-psi CWP, lead free cast-iron body; with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure.

PART 3 - EXECUTION

3.1 INSTALLATIONS

A. Install valves in accordance with manufacturer’s installation instructions.

B. Locate valves for easy access and provide separate support where necessary. Provide access doors and fire rated access doors as required.

C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

D. Install three-valve bypass around each pressure reducing valve using throttling-type valves.

E. Install valves in horizontal piping with stem at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:

H. Swing Check Valves: Horizontal position with hinge pin level.

I. Wafer Check Valves: Horizontal or vertical position, between flanges.

3.2 VALVE ENDS SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-Inch and Smaller: Solder ends.
2. Copper Tube Sizes 2-1/2 Inch and Larger: flanged end.

3.3 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

A. Domestic Hot and Cold Water Service

VALVE TYPE	2” AND SMALLER	2-1/2” AND LARGER
Ball	150	N/A
Gate	125	125
Check	125	125

3.4 VALVE SCHEDULE

A. Gate Valves - 2 inch and smaller:

MANUFACTURER	SOLDER NRS
Apollo	102S-LF
Hammond	UP-668
Milwaukee	UP668
NIBCO	S-113-LF

B. Gate Valves - 2-1/2 inch and larger:

MANUFACTURER	OS&Y RS	NRS
Apollo	NA	610F-LFA
Milwaukee	F2885-M26	NA

C. Ball Valves (full port) – 2 inch and smaller:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Apollo (Conbraco)	77C-LF-200	77C-LF-100
Hammond	UP8311A	UP8301A
Milwaukee	UPBA-450	UPBA-400
NIBCO	S-585-80-LF	T-585-80-LF

D. Iron Body Ball Valves (full port) – 2-1/2” and larger:

MANUFACTURER	FLANGED ENDS
Apollo (Conbraco)	6PLF
Watts	G4000-FDA

E. Swing Check Valves – 2 inch and smaller:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Apollo	161S-LF	161T-LF
Milwaukee	UP1509	UP509
NIBCO	S-413-Y-LF	T-413-Y-LF

F. Swing Check Valves - 2-1/2 inch and larger:

MANUFACTURER	CLASS 125	CLASS 175
Apollo	910F-LFA	x
Milwaukee	F2974A26	x

1. x means not available.

G. Wafer Check Valves – Class 125:

MANUFACTURER	MODEL
Hammond	IR9253
Metraflex	CVOSS
Milwaukee	1400
NIBCO	W910-B-LF

3.5 APPLICATION SCHEDULE

A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:

1. Gate Valves, 2” and smaller: Class 125, with cast bronze body.
2. Gate Valves, 2-1/2”: Class 125 with cast-iron body.
3. Ball Valves, 2” and Smaller: Class 150, 600-psi CWP, with stem extension if installed in insulated pipe.,.
4. Ball Valves, 2-1/2” and larger: 200-psi CWP cast iron body.
5. Swing Check, 2-1/2” and smaller: Class 125, cast bronze, with rubber seat.
6. Check Valves, 2-1/2” and larger: Class 125, swing or wafer type as indicated.

3.6 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.7 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following:

1. Horizontal-piping hangers and supports.
2. Vertical-piping clamps.
3. Saddles and Shields.
4. Hanger-rod attachments.
5. Building attachments.
6. Spring hangers and supports.
7. Pre-engineered support strut systems
8. Pipe alignment guides.
9. Anchors.
10. Expansion Anchors.
11. Equipment supports.
1. Pre-engineered roof supports
12. Miscellaneous materials.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Plumbing Insulation", for high density insulation for protecting insulation vapor barrier and materials and methods for piping hanger installations.
2. Division 22 “Water Distribution Piping and Specialties”, for pipe hanger types and spacing for horizontal and vertical domestic water distribution and heat traced piping of sizes and materials indicated.
3. Division 22 “Sanitary Drainage & Vent Piping and Specialties”, for pipe hanger types and spacing for heat traced and cold sanitary piping of sizes and materials indicated.

1.2 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

1.3 SUBMITTALS

A. General: Submit the following in accordance with conditions of contract and Division 01 specification Sections.

1. Product data, including installation instructions for each type of support and anchor.
2. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.
3. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
4. Assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
5. Maintenance data for supports and anchors for inclusion in Operating and Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."
6. Submit style and type of anchors to Architect or Structural Engineer for approval prior to installation.

1.4 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications.".

C. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.

D. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Hangers, supports, and components shall be listed and labeled by a NRTL where used for fire protection piping systems. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Hangers and Supports

1. Armacell.
2. Anvil International.
3. B-Line.
4. Elite Components
5. Halfen-DEHA.
6. Hilti.
7. ERICO\Michigan Hanger Co..
8. FNW
9. Midwest.
10. National Pipe Hanger Corporation.
11. Power-Strut.
12. Truscon.
13. Unistrut.

B. Pre-Insulated Supports:

1. Calcium Silicate Shield Supports:

a. Cooper B-Line, Inc.
b. Buckaroos, Inc.

2. Pre-Engineered Thermal Hanger Inserts:

a. Armacell “Armafix”.
b. Cooper B-Line, Inc.

C. Expansion Anchors:

1. Hilti.
2. Phillips.

3. Power Fasteners.
4. Rawl.

D. Pre-Engineered Roof Pipe Supports:

1. Airtec.
2. B-Line.
3. ERICO.
4. FNW
5. MIRO.
6. Roof Top Blox.

2.2 SUPPORT MATERIALS

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

2.3 SADDLES AND SHIELDS

A. Pipe Covering Protection Saddles:

1. Sheet metal construction, meeting MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12” and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12” long.

B. Pre-Insulated Supports:

1. Calcium Silicate Shield Supports:

a. Waterproofed calcium silicate conforming to ASTM C795 encased with an insulation protection shield.

2. Pre-Engineered Thermal Hanger Inserts:

a. Flexible elastomeric insulation conforming to ASTM C534, Type I with integral high density pipe support.

C. Insulation Protection Shield:

1. Sheet metal construction, meeting MSS SP-69 & SP-58 Type 40, of 18 gauge for 5-1/2” inside dimension and smaller, 16 gauge for 6-1/2” to 10-3/4” inside dimension 14 gauge for 11-3/4” to 17” inside dimension, and 12 gauge for 18” to 28” inside dimension. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

a. Length: Minimum 8 inch long section at each support joint.
b. For pipes 2 inch and smaller using fiberglass or flexible elastomeric insulation without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe	Insulation	Minimum Shield Length, (in)

Size (NPS)	Thickness (inches)	Hanger Spacing, (ft) 5	6	7	8	9	10
	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
≤ 1	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
≤ 2	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

2. 360° Insulation Protection Shield: Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

D. Hangers with pre-manufactured polymer inserts:

1. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally may be used in lieu of other insulated pipe support systems. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Note: Metal shields are not required with clevis hangers of this type. Approved manufacturers include:

a. Klo-Shure.
b. Anvil.
c. Holdrite.

2.4 PRE-ENGINEERED SUPPORT STRUT SYSTEMS

A. Support strut systems shall comply with MSS SP-69, Type 59. Shop- or field-fabricated pipe-support assembly shall be made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts. Minimum 14 gauge galvanized steel with factory-punched attachment holes. Two piece straps shall be captivated at the shoulder when attachment nut is tightened and designed for use with strut system. Long or short pipe rollers designed for use with strut system, where indicated, shall attach to the channel with brackets and nuts. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated. All nuts, brackets and clamps shall have the same finish as the channels.

2.5 PIPE ALIGNMENT GUIDES

A. Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

2.6 EXPANSION ANCHORS

A. Self drilling, drilled flush or shell type.

2.7 PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Nominal 4” X 4” X 12” long closed cell polyethylene blocks with embedded pre-engineered support strut or pre-engineered support struts with factory plastic bases. Two piece straps shall be captivated at the shoulder when attachment nut is tightened and designed for use with strut system. All nuts, brackets and clamps shall have the same finish as the channels.

2.8 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: Conforming to ASTM A 36.

B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install hangers and supports in accordance with manufacturer’s installation instructions.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, clamps and attachments to support piping properly from building structure.

B. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

C. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.
3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
4. Refer to Section 220700 for definition of hot and cold piping and required insulation thickness.

D. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

G. Field-Fabricated, Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS D-1.1.

H. Support fire protection systems piping independently from other piping systems.

I. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

J. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

L. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamps, including spacers (if any), to piping with riser clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section “Plumbing Insulation”.
2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
3. Insulation Protection Shield: Install insulation protection shield and high density insulation where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section “Plumbing Insulation”.

    a. Exception for horizontal cold piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage as specified in Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment.”

4. Contractor’s Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inch and larger.
5. Contractor’s Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

M. Pre-engineered Support Strut Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer’s recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer’s recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
2. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section “Plumbing Insulation”.

N. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.

O. Pre-Engineered Roof Pipe Supports: Set supports on an 18” X 18” x 3/16” thick roof walkway material compatible with the roof material.

3.3 INSTALLATION OF PIPE ALIGNMENT GUIDES

A. Install pipe alignment guides on piping that adjoins expansion joints, as required by expansion joint manufacturer, and elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems. Install guides per ASME B31.9 unless noted otherwise.

B. Anchor to building substrate.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper 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 anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

D. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

B. Grouting: Place grout under supports for piping and equipment.

3.6 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

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 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.7 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

   1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 220529

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SECTION 220548 - SEISMIC CONTROLS FOR PLUMBING SYSTEMS

PART 1 - GENERAL REQUIREMENTS

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 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 20 Section “Seismic Controls for MEP/F/T Systems” for general requirement and related documents that apply to this section.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 SUMMARY

A. Seismic bracing, restraints, and controls for all plumbing systems specified herein shall be designed and installed as required by Division 20 Section “Seismic Controls for MEP/F/T Systems”.

1.5 SUBMITTALS

A. Provide submittals as required by Division 20 Section “Seismic Controls for MEP/F/T Systems” for all plumbing systems specified herein.

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION 220548

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SECTION 220550 – VIBRATION ISOLATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. It is the intent of this specification to provide vibration isolation supports for Plumbing equipment as scheduled at the end of this Section.

B. This work shall include all materials and labor required for the installation of the vibration isolation devices.

C. Vibration isolators shall be selected by the weight distribution to produce reasonably uniform deflection. Deflections shall be as noted on the equipment schedule included at the end of this Section.

D. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.

E. All vibration isolation devices shall be treated for corrosion resistance using galvanization for exterior applications and painting for interior applications.

F. Related Sections:

1. Division 22 Section “Common Work Results for Plumbing” for materials and methods for concrete equipment pads.
2. Division 22 Section "Basic Piping Material and Methods," for materials and methods for flexible connectors.
3. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hangers and supports.
4. Division 22 Section “Domestic Booster Pumps,” for materials and methods for domestic booster pumps.

1.2 WORK INCLUDED

A. Provide complete vibration isolation systems as shown or specified and in accordance with the requirements of the Contract Documents. System shall be complete with:

1. Foundations, vibration isolation, and supports for rigidly supported equipment.
2. Vibration Isolation

1.3 RELATED WORK SPECIFIED ELSEWHERE

1.4 CONTRACTOR'S RESPONSIBILITY

A. Consult all other Section to determine the extent of work specified elsewhere but related to this Section. This work shall be properly coordinated to produce an installation satisfactory to the Owner. The Contractor shall be responsible for verifying the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be provided by the Contractor without claim for additional payment.

B. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly to the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.

1.5 MANUFACTURER'S RESPONSIBILITIES

A. Manufacturer of vibration isolation equipment shall have the following responsibilities:

1. Determine vibration isolation for all equipment and systems in accordance with the local governing code.
2. Provide piping and equipment isolation systems as scheduled or specified.
3. Guarantee specified isolation system deflection.
4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
5. The vibration isolation systems shall be guaranteed to have deflection indicated on the schedule on the drawings. Mounting sizes shall be determined by the mounting manufacturer, and the sizes shall be installed in accordance with the manufacturer's instructions.
6. The vibration isolator vendor shall ensure that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators. Where additional support structure is required, this shall be provided by vibration isolator vendor.

1.6 SUBMITTALS

A. Submittal data shall show type, size, and deflection of each isolator proposed. Include clearly outlined procedures for installing and adjusting the isolators.

B. Submit a vibration isolation system schedule indicating the following:

1. Manufacturer, type, model number, size
2. Height when uncompressed and static deflection of each isolation element
3. Spring constant of each isolation element
4. Estimated imposed load on each isolation element
5. Spring o.d., free operating, and solid heights
6. Design of supplementary bases.
7. Layout of isolator hangers, mounts, and other elements shown on an outline of the isolated equipment, including complete details of attachment to load-bearing structure or supplementary framing.
8. Piping isolators shown and identified on piping layout drawings.
9. All concrete foundations and supports (and required reinforcing and forms) will be furnished and installed by another trade. However, this trade shall furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required hanger bolts and other appurtenances necessary for the proper installation of his equipment. Although another trade will complete all concrete work, all such work shall be shown in detail on the shop drawings, prepared by this trade which drawings shall be submitted showing the complete details of all foundations including necessary concrete and steel work, vibration isolation devices, etc.

1.7 QUALITY ASSURANCE

A. It is the objective of this Specification to provide for the control of vibration due to the operation of machinery or equipment, and/or due to interconnected piping or conduit.

B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. All vibration isolation equipment and materials shall be provided by a single manufacturer. The following manufacturers are approved provided systems are in compliance with the specified design and performance requirements:

1. Amber Booth.
2. Kinetics Noise Control.
3. Mason Industries, Inc.
4. Vibration Eliminator Co., Inc.
5. Vibration Mounting and Controls.

2.2 GENERAL

A. All equipment provided for vibration isolation shall be new and manufactured specifically for the purpose intended.

2.3 VIBRATION ISOLATORS

A. GENERAL

1. The static deflection of isolators shall be as given in the equipment schedule and specified below. The isolator schedule shall take precedence.
2. Vibration isolator sizes and layout shall be determined by the vibration isolator supplier.
3. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, the amount of deflection 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.
4. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.
5. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than ±10%.
6. All neoprene mountings shall have a Shore hardness of 30 to 60 ±5, or as specified herein, after minimum aging of 20 days or corresponding over-aging.
7. Housed or caged spring isolators are not acceptable.
8. Where steel spring isolation systems are described in the specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 0.8 of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation. All isolators shall operate in the linear portion of their load versus deflection curve and have 50% excess capacity without becoming coil bound.
9. All mounting systems exposed to weather and other corrosive environments shall be protected with factory corrosion resistance. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized. Springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated.

B. ISOLATOR TYPE MWP

1. Type MWP (Metal and Waffle Sandwich Pads) shall consist of two 5/16 inch thick ribbed or waffle neoprene pads sandwiching a 16 gauge stainless steel shim plate. The pad shall be manufactured with bridge bearing quality neoprene, and selected for a maximum durometer of 50 and designed for 15% strain.
2. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660, or as approved) shall be installed under the bolt head between the steel washer and the base plate.
3. (Type MWP: Mason Industries Type WSW or as approved.)

C. NEOPRENE MOUNTING SLEEVES

1. Neoprene mounting sleeves for hold-down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.

D. PIPE FLEXIBLE CONNECTORS

1. Refer to Section “Basic Piping Materials and Methods” for requirements for flexible pipe connectors.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment, piping, etc. shall be mounted on or suspended from approved foundations and supports, all as specified herein, or as shown on the drawings.

B. All floor-mounted equipment shall be erected on concrete equipment pads over the complete floor area of the equipment, unless otherwise specified herein. Refer to Section “Basic Piping Materials and Methods” for concrete equipment pad requirements. These pads shall be integrally keyed to structural slab. Wherever vibration eliminating devices and/or concrete inertia blocks are specified, these items shall, in all cases, be mounted on concrete equipment pads unless otherwise specified herein.

C. Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.

D. All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 1/4" maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.

E. Piping or plumbing equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.

F. All wiring connections to plumbing equipment on isolators shall be made with a minimum 18 inch long flexible conduit in a “U” shaped loop.

G. Refer to Vibration Isolation Schedule at the end of this Section.

3.2 DOMESTIC BOOSTER PUMPS

A. Packaged domestic booster pumps installed on slab on grade shall be bolted and grouted thru their factory provided equipment frames to equipment pads and be provided with vibration isolators as scheduled in the table at the end of this section.

3.3 SUPPORT OF PIPING

A. The following water and condensate piping shall be resiliently supported:

1. Piping within 50 feet of connected rotating equipment.

B.

C. Where a pipe run connects multiple items of equipment in the mechanical room the pipe isolators for the entire run shall be chosen to suit the connected equipment of greatest static deflection.

D. Resilient diagonal mountings or other approved devices shall be provided as required to limit piping motion due to equipment startup or shut down, to a maximum of 1/8".

E. Water piping hanger rod isolators shall contain a steel spring in series with a 1/4" acoustical neoprene pad within a steel box retainer. The hanger rod isolator assembly shall be rigidly supported from the spring sub-assembly and shall not contact the steel box retainer. Clearances in the isolator design shall be capable of accepting a 15 degree misalignment in any direction from the vertical.

F. The steel spring element of the assembly shall be designed to have a minimum surge frequency of 340 HZ and a minimum deflection of 3/4".

G. Hanger rod isolators for steam and condensate piping including steam pressure reducing valve stations shall be supported by means of neoprene-in-shear mountings providing a minimum static deflection of 1/2".

H. Where supplementary steel is required to support piping, the supplementary steel shall be sized so that maximum deflection between supports does not exceed 0.08" and shall be resiliently supported from the building structure with mountings as described above. Supported piping from the supplementary steel shall be rigidly suspended or supported.

3.4 PIPING ANCHORS, GUIDES AND SUPPORTS

A. General: Pipe riser guides, anchors and supports including piping anchors in mechanical equipment rooms or occupied spaces shall be isolated from the building structure such that there shall be no direct metal to metal contact of the piping with the building structure.

B. Piping Anchors and Guides

1. The all directional pipe anchor isolation mountings shall consist of a telescoping arrangement of two sizes of steel tubing separated by a minimum of 1/2" thick heavy duty neoprene and canvas duct isolation pad. Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction. The allowable load on the isolation material shall not exceed 500 psi.
2. Steel guides shall be welded to the pipe at a maximum spacing of 90°. The outside diameter of the opposing guide bars shall be smaller than the inside diameter of the pipe riser clamp in accordance with standard field construction practice. Each end of the pipe guide shall be rigidly attached to an all directional pipe anchor isolation mounting which in turn, shall be rigidly fastened to the steel framing within the shaft.
3. Low temperature piping guides shall be constructed with a 360 degree 10 gauge metal sleeve around the piping. The thermal insulation requirements for the piping shall be provided between the piping and the sleeve. Heavy duty neoprene and canvas duct isolation pad of thickness equal to thermal insulation requirements shall space the metal sleeve away from the piping with urethane or other suitable thermal insulation provided in the voids

between the pipe-sleeve and isolation pan material. The metal sleeve outside diameter shall be smaller than the pipe riser clamp inside diameter in accordance with standard field construction practice. The pipe riser clamp shall be rigidly attached to the steel framing within the shaft.

C. Piping Supports:

1. Piping isolation supports at the base of risers shall be two layers of 1/2" thick heavy duty neoprene and canvas duct isolation pad separated by 1/4" thick steel plate. Suitable bearing plates sized to provide a pad loading of 500 psi maximum shall be provided. The stanchion between the pipe and isolation support shall be welded to the pipe and welded or bolted to the isolation support. The isolation support shall be bolted to the floor slab with resilient sleeves and washers. All pipe support resilient materials shall be HL Mason Industries, Inc., or as approved.

3.5 FLEXIBLE PIPING CONNECTORS

A. Flexible piping connectors shall be installed to connect piping diameter 2” or greater to reciprocating or rotating equipment.

3.6 PIPE RISER SUPPORTS

A. Where pipes rise in a vertical chase and are supported from a structure with type SPNH or DDNH isolators and require lateral bracing, neoprene riser guides shall be mounted around the pipe to limit lateral movement and to prevent direct contact with the supporting structure.

B. Support vertical pipe risers subjected to thermal expansion and/or contraction with spring isolators and central anchors designed to ensure loading within design limits at support points. Perform design calculations for sizing the riser supports incorporating the initial load, initial deflection, change in deflection, final load and change in load at support locations. Design calculations must include anchor loads when installed, cold filled and at operating temperature and pipe stress at end connections and branch locations. Design system for an initial spring deflection of at least 4 times the thermal movement. Design must be stamped and signed by a licensed professional engineer.

3.7 WIRING

A. All wiring connections to plumbing equipment on vibration isolators (either spring or neoprene type) shall be made with a minimum 18 inch long flexible conduit in a “U” shaped loop. This Contractor shall coordinate wiring connections with the Electrical Contractor.

3.8 FIELD QUALITY

A. Contractor shall work in accord with best trade practices, shall fabricate and install all items in accordance with manufacturer's recommendations and Architect's directions, and shall consult with trades doing adjoining work in order to provide an installation of first class quality.

3.9 ADJUSTMENT AND TESTING

A. Site Access: During installation of equipment, Contractor shall arrange for access as necessary for inspection of isolation and noise control equipment by Architect and his representatives.

B. Contractor’s Vibration Isolation Report: The vibration isolation vendor shall inspect and approve the installation of the vibration isolators and shall submit a report to the Architect which verifies that all of the isolation equipment has been properly installed and that the installation is in full

conformance with the specification. The report shall record the vibration isolator identification and model or type. For isolators containing steel springs the report shall also record the size and uncompressed height, design static deflection and measured static deflection of the isolators provided.

C. Consultant's Inspection: Upon completing installation and adjustment for suitable operation of all work specified under this section, the Contractor shall notify the Architect in writing. The letter shall certify that all work specified under this section is complete, operational and adjusted in every respect, and that all work is ready for the completion checkout. The notification letter shall be accompanied by the vibration isolation report.

3.10 GUARANTEE

A. If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

3.11 SCHEDULE OF VIBRATION ISOLATORS

EQUIPMENT	BASE TYPE	ISOLATOR TYPE	STATIC DEFLECTION
Domestic Booster Pumps (Slab on Grade)	Equipment Pad	MWP	0.25
Piping		Isolation as per specification.	

END OF SECTION 220550

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.

B. Types of identification devices specified in this Section include the following:

1. Painted Identification Materials
2. Plastic Pipe Markers
3. Plastic Tape
4. Underground-Type Plastic Line Marker
5. Valve Tags
6. Valve Schedule Frames
7. Plastic Equipment Markers
8. Plasticized Tags

1.2 CODES AND STANDARDS:

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

C. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section “General Plumbing Requirements.”

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:

1. Allen Systems, Inc.
2. Brady (W.H.) Co.; Signmark Div.
3. Industrial Safety Supply Co., Inc.
4. Seton Name Plate Corp.

2.2 PLUMBING IDENTIFICATION MATERIALS

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS

A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications. Minimum letter height shall be 1-1/4" high letters for ductwork and 3/4" high letters for access door signs and similar operational instructions.

B. Stencil Paint: Stencil paint shall be exterior type, oil based, alkyd enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Identification paint shall be oil based, alkyd enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

2.4 PLASTIC PIPE MARKERS

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1

B. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.

C. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the 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" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

D. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the 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" wide; full circle at both ends of pipe marker, tape lapped 3".
3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

E. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

F. Lettering: Comply with piping system nomenclature as specified, scheduled, or shown, and abbreviate only as necessary for each application length.

2.5 UNDERGROUND-TYPE PLASTIC LINE MARKER

A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of buried pipe.

1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.6 PLASTIC TAPE

A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.

C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.7 VALVE TAGS

A. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16" high letters and sequenced valve numbers approximately 3/8" high, and with 5/32" hole for fastener.

1. Provide 1-1/8" sq. white tags with black lettering.

B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.8 VALVE SCHEDULE FRAMES

A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.9 PLASTIC EQUIPMENT MARKERS

A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Yellow/Green: Combination cooling and heating equipment and components.
4. Brown: Energy reclamation equipment and components.
5. Blue: Equipment and components that do not meet any of the above criteria.
6. For hazardous equipment, provide colors and designs recommended by ANSI A13.1.

B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and plan number.
2. Equipment service.

3. Design capacity.
4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

C. Size: Provide 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

2.10 PLASTICIZED TAGS

A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing. Tags shall be minimum 3-1/4" x 5-5/8" in size, provided with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.11 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Application: Provide piping system identification for the following systems:

1. Domestic cold water piping.
2. Domestic hot water piping.
3. Domestic hot water recirculating piping.
4. Non potable water piping
5. Lawn irrigation piping.
6. Sanitary and waste piping.
7. Storm water piping.
8. Vent piping.
9. Insulated and non-insulated storm water piping.

10. Compressed air piping
11. Natural gas piping.

C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Within 5 feet of each valve and control device.
2. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.
3. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Within 5 feet of major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

3.3 UNDERGROUND PIPING IDENTIFICATION

A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units.

B. List each tagged valve in valve schedule for each piping system. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.5 PLUMBING EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Pumps
3. Heat exchangers
4. Water heaters, tanks and pressure vessels.

B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.

C. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Plumbing insulation required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Types of Plumbing insulation specified in this Section include the following:

1. Piping Systems Insulation:

a. Fiberglass
b. Flexible Elastomeric

1.2 QUALITY ASSURANCE

A. Flame/Smoke Ratings: Provide composite Plumbing insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E 84 (NFPA 255) method.

1. Exception: Outdoor Plumbing insulation may have flame spread index of 75 and smoke developed index of 150.
2. Exception: Industrial Plumbing insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields for protecting insulation vapor barrier and materials and methods for piping installations.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of Plumbing insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each Plumbing system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of Plumbing insulation. Include this data and product data in maintenance manual.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1. Aeroflex USA, Inc.
2. Armacell LLC.
3. CertainTeed Corp.
4. Knauf Insulation
5. Johns Manville
6. K-Flex USA

7. Owens Corning

2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated.

B. Flexible Elastomeric Piping Insulation: ASTM C534, Type I.

C. Jackets for Piping Insulation: ASTM C1136, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

1. PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, Johns Manville Zeston 2000 PVC or approved equivalent. Factory supplied, pre-cut insulation blanket inserts for use with PVC fitting covers are acceptable.

D. Jackets for Pipe Insulation Exposed to Weather (All Insulation except Flexible Elastomeric): Approved by the jacket manufacturer for use with the specific insulation material that it covers.]

1. Rigid aluminum shell and fitting covers conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

[Outer Insulation Diameter (in) | Minimum Aluminum Jacket Thickness, (in) Non-Rigid Insulation | Rigid Insulation | Finish

Diameter (in)	Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco
≤ 36	0.032	0.020	See Note 1
> 36	0.040	0.024	See Note 1

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

a. Banding:

1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

2. Cladding consisting of a UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulated duct and piping applications.

a. Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equivalent.

E. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

G. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

H. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's installation instructions.

3.2 PLUMBING PIPING SYSTEM INSULATION

A. Insulation Omitted: Omit insulation on the following:

1. Chrome-plated exposed piping
2. Water Hammer Arrestors
3. Balancing and flow valves
4. Drain lines from water coolers
5. Drainage piping located in crawl spaces or tunnels
6. Exterior condensate drain piping
7. Buried piping
8. Pre-insulated equipment.

B. Cold Piping:

1. Application Requirements: Insulate the following cold plumbing piping systems:

a. Potable cold water piping.
b. Plumbing vents within 6 lineal feet of roof outlet.
c. Horizontal and vertical interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
d. Condensate piping inside the building.
e. Trap arms, waste branches and dedicated stacks serving condensate drains.

2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 1" thickness.

C. Hot Piping:

1. Application Requirements: Insulate the following hot plumbing piping systems:

a. Potable hot water piping.
b. Potable hot water recirculation piping.
c. Hot drain piping (where indicated).

2. Insulate hot water piping systems up to 140F specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 1-1/2" thick for pipe sizes up to and including 1-1/2" and smaller, 2" thick for pipe sizes 2" and larger.

D. P-traps:

1. Insulate P-traps receiving hot water waste above 140F as described below:

    a. Fiberglass: 1" thickness.

3.3 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.

C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

E. Clean and dry pipe surfaces prior to insulating.

F. Pipe insulation:

1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section “Hangers and Supports for Plumbing Piping” for pre-insulated supports.
3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section “Hangers & Supports for Plumbing Piping” for insulation shields.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints.
6. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints.
7. For cold pipes, apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

G. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves (except balancing and flow control 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. Butt tightly against adjoining pieces and bond 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, install fitted PVC cover over elbows, tees, strainers, valves (except balancing and flow control 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.

H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. 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.

I. 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 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.

J. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

3.4 EXISTING INSULATION REPAIR

A. Repair damaged sections of existing Plumbing insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.5 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 220700

SECTION 220800 - COMMISSIONING OF PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. See Section 019113 - General Commissioning Requirements for Contractor's commissioning responsibilities and Commissioning Scope of Work, including a list of systems to be commissioned. Comply with requirements of Section 019113.

B. The Commissioning Authority (3PCx) directs and coordinates all commissioning activities as described in Section 019113.

1.02 RELATED REQUIREMENTS

A. Section 019113 - General Commissioning Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

4.01 OPERATION AND MAINTENANCE MANUALS

A. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

B. See Section 017800 for additional requirements.

END OF SECTION

SECTION 221100 - WATER DISTRIBUTION PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties within the building to a point 5 feet outside the building.

1. in Division 22 Section 221111 “Mechanically Joined Plumbing Piping Systems”.

B. Contractors Option:

1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined water distribution piping systems where used shall be provided in compliance with specification Section 221111 “Mechanically Joined Plumbing Piping Systems”.

2. The Division 22 contractor may provide CPVC water distribution piping systems in lieu of, in whole or in part, for copper tube water distribution systems 3” and larger. CPVC water distribution piping systems are specified in Division 22 Section 221115 “CPVC Water Distribution Systems and Specialties”.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
2. Division 2 Section "Water Service Systems," for water service piping beginning from 5'-0" outside the building.
3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
4. Division 22 Section "Identification, for Plumbing Piping and Equipment" for labeling and identification of water distribution piping.
5. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.
6. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, dielectric unions, dielectric flanges and mechanical sleeve seals.
7. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.
8. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials and methods for hanging and supporting water distribution piping.
9. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.
10. Division 22 Section “Sanitary Drainage and Vent Piping and Specialties,” for material and methods for trap primer outlet piping.

D. Products installed but not furnished under this Section include water meters that will be provided by the utility company to the site and ready for installation. Following is the name and address of the utility company:

_____

_____

_____

1.2 DEFINITIONS

A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.

B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.

C. Pipe sizes used in this Specification are nominal pipe size (NPS).

D. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

1. Product data for each piping specialty and valve specified.
2. Welder Certificates signed by Contractor certifying that welders comply with requirements specified in Article "Quality Assurance" below.
3. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
4. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
5. Test reports specified in Part 3 of this Section.
6. Submit certification that specialties and fittings for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following specialties need not comply:

    a. Hose bibbs
    b. Wall, yard and roof hydrants
    c. Backflow preventers isolating irrigation or mechanical make-up systems
    d. Emergency mixing valves
    e. Trap primers

1.4 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

B. Regulatory Requirements: Comply with the provisions of the following codes:

1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.

C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

D. Pipe, fittings and specialties shall be manufactured in the United States or be certified to meet ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Automatic Flow Control Valves:

   a. Calefi
   b. Flow Design, Inc., Autoflow Div.
   c. Victaulic Company

2. Hose Bibbs with Vacuum Breaker:

   a. Chicago Faucet Co.
   b. Eljer, A Household International Company
   c. T & S Brass & Bronze Works, Inc.

3. Hose Bibbs:

   a. Lee Brass Co.
   b. Mansfield Plumbing Products
   c. Mifab Manufacturing, Inc.
   d. Nibco, Inc.
   e. Prier, Inc.
   f. Watts Regulator Co.
   g. Woodford Mfg. Co.

4. Wall/Yard Hydrants:

   a. Josam Co.
   b. Mifab Manufacturing, Inc.
   c. Smith (Jay R.) Mfg. Co.
   d. Prier, Inc.
   e. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
   f. Watts Drainage
   g. Woodford Mfg. Co.
   h. Zurn Industries Inc., Hydromechanics Div.

5. Backflow Preventers:

   a. Cla-Val Co.
   b. Conbraco Industries, Inc.

c. Febco
d. Hersey Products, Inc.
e. Mifab Manufacturing, Inc./Beeco
f. Watts Regulator Co.
g. Zurn Industries Inc. Wilkins Regulator Div.

6. Self Contained Pressure-Reducing Valves:

a. Cash (A. W.) Valve Mfg. Corp.
b. Cla-Val Co.
c. Conbraco Industries, Inc.Watts Regulator Co.
d. Zurn Industries Inc., Wilkins Regulator Div.
e. Mifab Manufacturing, Inc./Beeco

7. Pilot Operated Pressure-Reducing Valves:

a. Cla-Val Co.
b. Conbraco Industries, Inc.
c. Mifab Manufacturing, Inc./Beeco
d. OCV
e. Watts Regulator Co.
f. Zurn Industries Inc. Wilkins Regulator Div.

8. Water Meters:

a. Badger Meter, Inc.
b. Hays Div., Romac Industries
c. Hersey Products, Inc.
d. Neptune Water Meter Co.; Subs. Neptune Intl. Corp.
e. Rockwell Intl.; Measurement & Flow Control Div.

9. Relief Valves:

a. Cash (A. W.) Valve Mfg. Corp.
b. Conbraco Industries, Inc.
c. Watts Regulator Co.
d. Zurn Industries, Inc. Wilkins Regulator Div.

10. Piston Type Water Hammer Arresters:

a. Amtrol, Inc.
b. Josam Co.
c. Precision Plumbing Products, Inc.
d. PROFLO
e. Sioux Chief Manufacturing Co.
f. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
g. Watts Regulator Co.
h. Zurn Industries, Inc. Wilkins Regulator Div.

11. Point of Use Thermostatic Mixing Valves

a. Acorn Engineering Co.
b. Cash Acme
c. Leonard Valve Co.
d. Powers Process Controls

12. Trap Primers and Distribution Units

    a. Precision Plumbing Products, Inc.
    b. MIFAB MANUFACTURING, INC.
    c. PROFLO
    d. Sioux Chief

13. Plumbing Pipe Support Brackets

    a. Holdrite
    b. PROFLO
    c. Sioux Chief

14. Tube Suspension Clamps

    a. PROFLO
    b. Sioux Chief or approved Equivalent

15. Sanitary Roof Hydrants

    a. Hoeptner Perfected Products
    b. Jay R. Smith Mtg Co.
    c. Mapa
    d. Woodford Mfg. Co.

2.2 PIPE AND TUBE MATERIALS, GENERAL

A. Pipe and Tube: Refer to Part 3, Articles "Above Ground Water Distribution Pipe and Fittings" or “Below Ground Water Distribution Pipe and Fittings”, for identification of systems where the materials listed below are used.

B. Copper Tube: ASTM B88, Type L Water Tube, drawn temper.

C. Copper Tube: ASTM B88, Type K Water Tube, annealed temper.

D. Ductile-Iron Pipe: AWWA C151 or AWWA C115 ductile-iron pipe, with AWWA C104 cement-mortar lining.

2.3 FITTINGS

A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.

B. Galvanized Malleable Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ASME B1.20.1.

C. Ductile-Iron Gasketed Fittings: AWWA C110 or AWWA C153, 150 psi rating, with cement mortar lining and AWWA C111 rubber gaskets.

D. Brass Fittings: Chrome plated ANSI B16, Class 125 with threaded connections.

E. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125, raised ground face, bolt holes spot faced.

F. Bronze Flanges: ANSI B16.24, Class 150, raised ground face, bolt holes spot faced.

G. PVC to Ductile Iron Adapter Flanges: EBBA Iron, Inc. Series 2000PV or approved equivalent.

2.4 JOINING MATERIALS

A. Solder Filler Metal: ASTM B32 Alloy Sb-5, 95-5 Tin-Antimony.

B. Brazing Filler Metals: AWS A5.8, BAg Silver.

C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and design temperatures and pressures.

2.5 GENERAL-DUTY VALVES

A. General-duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 22 Section "General Duty Valves for Plumbing Piping." Special duty valves are specified below by their generic name; refer to Part 3, Article "Valve Applications" for specific uses and applications for each valve specified.

2.6 SPECIAL DUTY VALVES.

A. Automatic Flow Control Valves: 400 PSI WOG, flow regulator, with series 300 stainless steel body, series 300 stainless steel automatic pre-set flow balancing cartridge, union connection body, and threaded-end connections.

2.7 PIPING SPECIALTIES

A. Hose Connections: Hose connections shall have garden hose thread outlets conforming to ASME B1.20.7.

B. Hose Bibbs: Bronze body with chrome- or nickel-plated finish, with renewable composition disc, wheel handle, 1/2- or 3/4-inch solder inlet, hose outlet.

C. Recessed Nonfreeze Wall Hydrants: Cast-bronze box, with chrome-plated face, tee handle key, vacuum breaker, hinged locking cover, 3/4-inch inlet, and hose outlet. Bronze casing shall be length to suit wall thickness.

D. Roof Hydrants: As specified on the drawings.

E. Backflow Preventers: Comply with requirements of ASSE Standard 1013 and as specified on the drawings.

F. Pressure Reducing Valves: Comply with requirements of ASSE Standard 1003 and as specified on the drawings.

G. Water Meters: Provide water meters with registration in gallons.

1. Water Meter - 2 Inches And Smaller: Disc type conforming to AWWA C700.
2. Water Meter - 3 Inches And Larger: Compound type, conforming to AWWA C702.
3. Remote Registration System: Utility company standards.

H. Relief Valves: Sizes for relief valves shall be in accordance with ASME Boiler and Pressure Vessel Codes for indicated capacity of the appliance for which installed.

1. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Temperature relief valves shall be factory set at 210 deg F, and pressure relief at 150 psi.

I. Piston Type Water Hammer Arresters: Piston type, with casing of type “L” copper tube and spun copper ends, nylon piston with two EPDM “O”rings pressure lubricated with FDA approved silicone, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.

J. Point of Use Thermostatic Mixing Valves:

1. Lead free bronze or brass body meeting ASTM B584 with non-corrosive parts, tamper resistant temperature adjustment, checks, stops, other components as scheduled and meeting ASSE 1070. Valve shall be designed to fail to the cold side of the system. Maximum

K. Trap Primers: Brass construction, line pressure operation, capacity to prime number of traps as indicated with distribution units complying with requirements of ASSE Standard 1018.

L. Pipe Support Brackets:

1. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of ½” on 2” centers and holes of ¾” or 1” on 4” centers.
2. Pipe Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent pipe in wall.
3. Carrier Bracket: 20 gauge copper bracket with 1” hole for supporting rough-in for flush valve copper tube and bolt slot for attaching to chair carrier.

M. Tube Suspension Clamps

1. Combination plastic supports and insulators for installing copper tube in stud walls with integral bracket for securing to stud with screws.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install piping, valves and specialties in accordance with manufacturer’s installation instructions.

3.2 PREPARATION FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. PVC Service Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to prevent pipe deflection and then install subbase. Refer to Section “General Plumbing Requirements” for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 “Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications” for additional requirements.

B. Copper Tube: Provide 6” thick sand pipe bed underneath and around sides of pipe, up to middle half of the pipe. Support pipe in trench with sand bags level and true at fittings to prevent sand, gravel or debris from interfering with the brazing process. After pressure testing is complete, install bedding at fittings and install subbase. Refer to Section “General Plumbing Requirements” for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

C. Ductile Iron Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the

foundation. For piping with rock trench bottoms, provide sand pipe bed 6” underneath and around sides of pipe up to middle half of the pipe, including fittings. After pressure testing is complete, provide first layer of pea gravel backfill 6” above pipe, tamp backfill with mechanical tamper and install bedding at fittings and install subbase. Refer to Section “General Plumbing Requirements” for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.3 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 8 inches and smaller, within the building.

B. Install chrome plated brass pipe and fittings for exposed water piping within the building where indicated on the drawings.

3.4 BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Install Type K, soft annealed copper tube and brazed joints for pipe sizes 2 inches and smaller, with minimum number of joints, inside and outside building.

B. Install cement-lined ductile-iron pipe with rubber gasketed joints, inside and outside building, for pipe 3” and larger.

C. Install AWWA C900 PVC service pipe with belled-end joints from 5’-0” outside the building.

3.5 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.

I. Fire Barrier Penetrations: Where pipes pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section “Common Work Results for Plumbing” for special sealers and materials.

J. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves packing, and sealant. Refer to Division 22 Section “Basic Piping Materials and Methods” for additional information.

K. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 22 Section “Basic Piping Materials and Methods” for additional information.

L. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods” for special sealers and materials.

M. Install piping with 1/32-inch-per-foot (1/4 percent) downward slope towards drain point.

N. Install piping level with no pitch.

3.6 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping”. Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs. Provide copper coated riser clamps when in contact with copper tube.
3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections “Supports and Anchors” and “Plumbing Insulation”.
4. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2” and smaller on walls and for securing 1-1/4” to 2” copper tube inside walls and chases for battery fixtures. Secure clamp to the copper tube.

    a. Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section “Mechanical Insulation” for requirement for maintenance of the vapor barrier and vapor barrier seal method.

5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of stainless steel tube 2” and smaller on walls or for securing tube inside walls for connection to faucets.
6. Support copper tube in chases and walls at plumbing fixtures with plastic or copper brackets secured to structure and U-bolts sized to bare on the pipe.
7. Engineered strut support system may be provided, at the contractor’s option, in lieu of individual hangers for horizontal pipes as specified in Division 22 “Hangers and Supports for Plumbing Piping”. Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube. Provide two piece straps and 360° insulation protection shields sized for the insulation thickness used for the pipe for all insulated pipes.

8. Secure copper tube rough-in for individual fixtures with sheet stud brackets attached to the wall studs or pipe mounting brackets attached to the fixture waste & vent pipe at each plumbing fixture.
9. Secure 1” and smaller copper water tubing in stud walls at stud penetrations with tube suspension clamps.

    a. Cut hole through non-supporting studs with a minimum 1/8” clearance around each uninsulated copper tube or insulated copper tube.
    b. Seal each joint of insulation and tube suspension clamp to maintain the insulation barrier. Refer to Division 22 “Plumbing Insulation” for requirement for maintenance of the vapor barrier similar to insulation butted against insulation inserts and vapor barrier seal method.

10. Secure copper tubes for flush valve wall mounted water closets to the chair carrier with carrier brackets.

C. Install hangers for horizontal piping with the following maximum spacing and minimum rod sizes:

Nom. Pipe Size - In.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8
2-1/2	9	1/2
3	10	1/2
3-1/2	11	1/2
4	12	5/8 (1/2 for copper)
5	13	5/8 (1/2 for copper)
6	14	3/4 (5/8 for copper)
8	16	7/8 (3/4 for copper)
10	18	7/8 (3/4 for copper)
12	19	7/8 (3/4 for copper)

1. Support vertical copper tube at each floor and in intervals not to exceed 10 feet.

D. Support water piping within 12” of each elbow or tee and for water piping 2-1/2” and larger at each valve or strainer.

E. Support water piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

F. Provide vibration isolation for piping connected to rotating equipment. Vibration isolators are specified in Division 22 specification Section “Vibration Isolation for Plumbing Piping and Equipment”.

3.7 PIPE AND TUBE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.
2. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
3. Heat joints to proper and uniform temperature.

C. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Align threads at point of assembly.
3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

a. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

D. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

E. Joints Containing Dissimilar Metals: Provide dielectric unions for 2” and smaller and dielectric flanges for piping 2-1/2” and larger. Provide dielectric waterway fittings for 2” and smaller in concealed locations. Dielectric unions, waterway fittings and flanges are specified in Section “Basic Piping Materials and Methods”.

F. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section “Basic Piping Materials and Methods”.

3.8 SERVICE ENTRANCE

A. Extend water distribution piping to connect to water service piping, of size and in location indicated for service entrance to building. Water service piping is specified in a separate section of Division 2.

B. Underground exterior water distribution piping to be a depth as required by local conditions, in accordance with authority having jurisdiction’s requirements and at depth no less than 18” below grade.

C. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.

D. Install sleeve and caulk at penetrations through building floor for watertight installation.

E. Install shutoff valve at service entrance inside building; complete with strainer, pressure gauge, and test tee with valve.

F. Ductile-Iron Pipe: Install in accordance with AWWA C-600. Pipe below ground inside building and to a point 5 feet outside of building shall have restrained joints.

G. Copper Pipe: Install Type K, soft annealed copper tube and brazed joints, with minimum number of joints, to a point 5 feet outside of building. Install changes of direction larger than the manufacturer recommended minimum bend radius to prevent kinks in the line.

3.9 INSTALLATION OF WATER METER

A. Install water meter in accordance with utility company's installation instructions and requirements.

1. Provide three valve water meter by pass, sized per the authority having jurisdiction’s requirements.

B. Size meter and arrange piping and specialties to comply with utility company's requirements.

C. Set meter on concrete pad as indicated. Refer to Division 3 for concrete, formwork, and reinforcing requirements.

1. Mount meter on wall brackets as indicated.

3.10 ROUGH-IN FOR WATER METER

A. Install rough-in piping and specialties for water meter installation in accordance with utility company's instructions and requirements.

3.11 VALVE APPLICATIONS

A. General-Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shut-off duty: Use gate, ball, and butterfly valves.

B. Throttling duty: Use globe, ball, and butterfly valves.

3.12 INSTALLATION OF VALVES

A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inches and smaller, use gate or ball valves; for sectional valves 2-1/2 inches and larger, use ball, gate or butterfly valves.

B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, on each supply to each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inches and smaller, use gate or ball valves; for shutoff valves 2-1/2 inches and larger, use ball, gate or butterfly valves.

C. Drain Valves: Install drain valves on each plumbing equipment item, located to drain equipment completely for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For drain valves 2 inches and smaller, use gate or ball valves; for drain valves 2-1/2 inches and larger, use ball, gate or butterfly valves.

D. Check Valves: Install swing check valves on discharge side of each pump and elsewhere as indicated.

E. Hose Bibbs: Install on exposed piping where indicated with vacuum breaker.

F. Wall Hydrants: Install where indicated with vacuum breaker.

G. Point-of-Use Thermostatic Mixing Valve: Install valve complying with ASSE 1070 on all public lavatories and handwashing sink locations. Install valve to be accessible by maintenance staff. Set temperature limit to 110F for dual temperature faucet or 100F for single temperature faucet."

3.13 INSTALLATION OF FLOW CONTROL VALVES

A. Install flow automatic flow control valves in each hot water recirculating loop, and elsewhere as indicated. Install a shutoff valve and strainer upstream and a union, check valve and shutoff valve downstream of each flow control or automatic flow control valve.

B. Set flow control valve flow rate as follows:

1. Preliminary Procedures For Hot Water Return System Balancing:

a. Before operating the system perform these steps:

1) Open valves at recirculation pump and flow control valves to full open position.
2) Remove and clean all strainers.
3) Check recirculation pump rotation.
4) Set water heater temperature as indicated on the drawings.

2. Procedures For Hot Water Return System Balancing

a. Refer to the drawings for required flow rate for each flow control valve.
b. Provide required instrumentation to obtain proper measurements. Instruments shall be properly maintained and protected against damage.
c. Apply instrument as recommended by the manufacturer.
d. Take readings with the eye at the level of the indicated value to prevent parallax.
e. Mark flow control valve setting with memory stop. Mark with paint or other suitable, permanent identification materials.
f. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.14 TRAP PRIMERS

A. Install trap primers where indicated and where required by local authorities having jurisdiction.

B. Connect trap primer supply line to the top of domestic cold water line no larger than 1 ½" in diameter.

C. Provide trap primer distribution units for trap primers serving more than one trap.

D. Install trap primer distribution level to insure even water distribution unit to each circuit.

E. Where applicable, adjust the trap primer for proper flow.

F. Install trap primers a minimum of 12 inches above finished floor for every 20 feet of horizontal outlet piping to floor drains served.

G. Install trap primers in an accessible location.

H. Refer to Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for trap primer outlet pipe requirements.

3.15 INSTALLATION OF PIPING SPECIALTIES

A. Install backflow preventers at each connection to mechanical equipment and systems and in compliance with the plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Install air gap fitting and pipe relief outlet drain without valves to nearest floor drain.

B. Install pressure reducing valves with inlet and outlet shutoff valves and balance cock bypass. Install pressure gauge on valve outlet.

3.16 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2 inches and larger, use flanges instead of unions.

3.17 FIELD QUALITY CONTROL

A. Inspections: Inspect water distribution piping as follows:

1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

    a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.
    b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
    c. Reinspection's: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
    d. Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.

B. Piping System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.

4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.18 ADJUSTING AND CLEANING

A. Clean and disinfect water distribution piping as follows:

1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.
2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:

    a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
    b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.
    c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
    d. Following the allowed standing time, flush the system with clean, potable water until chlorine residual is lowered to incoming city water level.
    e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.

3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

3.19 COMMISSIONING

A. Fill the system. Check compression tanks to determine that they are not air bound and that the system is completely full of water.

B. Before operating the system, perform these steps:

1. Close drain valve, hydrants, and hose bibbs.
2. Open valves to full open position.
3. Remove and clean strainers.
4. Check pumps for proper direction of rotation. Correct improper wiring.
5. Lubricate pump motors and bearings.

END OF SECTION 221100

SECTION 221111 - MECHANICALLY JOINED PLUMBING PIPING SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section only applies to Mechanically Joined Plumbing Piping Systems for joining piping for Plumbing applications as defined in Division Section 22 “Water Distribution Piping and Specialties”.

B. The Division 22 contractor may provide mechanically joined, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods.

C. Mechanically joined couplings, fittings, valves and related components specified in this section shall not be provided for natural gas piping in lieu of welded, threaded or flanged piping methods.

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

B. CWP: Cold working pressure in psi.

C. CTS: Copper tube size.

1.3 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 22 section “Basic Plumbing Piping Materials and Methods” for materials for dielectric waterway fittings and flange kits.

B. Division 22 Section “Water Distribution Piping and Specialties” for related sections.

1.4 SUBMITTALS

A. Product Data: Submit data for each type of coupling, fitting and special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing.

B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.

1. If an assembly of flexible couplings are used for seismic vibration, thermal expansion, or noise and vibration reduction, submit shop drawings indicating location of assembly, including anchors and guides. Include movement analysis of the assembly, and performance data of the assembly.

C. Maintenance Data: Include for each piping specialty and valve in Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

E. Submit a schedule of dissimilar metal joints and adaptor flanges and flange kits. Include joint type material, connection method and proposed flange kits to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Dielectric flange kits are specified in Division 22 section “Basic Plumbing Piping Materials and Methods”.

F. Submit certification that valves and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

G. Submit certification that pipe, pipe fittings, pipe specialties, and valves and fittings are manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

H. Submit contractor certificates indicating completion of installation training course from manufacturer of piping to be used.

1.5 QUALITY ASSURANCE

A. All grooved and press to connect components shall be of one manufacturer, be date and origin stamped for quality assurance and traceability.

B. Grooved mechanical piping shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-39.1, ASME, UL/ULC, FM, IAPMO or ICC.

1. Components shall be capable of providing system rigidity to accommodate hanging and support in accordance with ANSI B31.1 and ANSI B31.9.

C. Grooved and press to connect end product manufacturer shall be ISO certified.

D. Grooved couplings shall meet the requirements of ASTM F-1476.

E. Grooving tools shall be of an approved manufacturer by the grooved fittings manufacturer. Verify tolerances of and maintain grooving tool components for duration of grooving processes. Replace grooving tool components that are found out of tolerance with new as required.

F. Obtain training from the grooved and press to connect manufacturer for all workers that will be installing or handling the grooved or press to connect piping systems.

G. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves and fittings containing no more than 0.25% lead by weight for domestic water distribution.

H. Pipe, fittings, specialties, and valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI, and MSS standards.

1.6 COORDINATION

A. Reference Division 22 Section “Water Distribution Piping and Specialties” for coordination.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Refer to manufacturer's current literature for comparable products and pressure ratings of couplings and standard fittings for various pipe sizes and pipe schedules. Products identified by model number are based on available size ranges from that manufacturer. Products offered by manufacturers with extended ranges are acceptable provided they meet the specified requirements.

B. Copper Grooved Copper Tubing System

1. Anvil International "Gruvlok".
2. Shurjoint Piping Products.
3. Victaulic Company of America.

C. Press to Connect Copper Tubing System

1. Apollo "Xpress"
2. GRINNELL Mechanical Products "G-Press"
3. NIBCO Inc., Press System.
4. Viega ProPress

2.2 COPPER GROOVED TUBING SYSTEM

A. Pipe:

1. 2 inch through 8 inch: CTS, ASTM B88 Type K or L, hard drawn.
2. Ends: Roll grooved only in accordance to manufacturer's current listed standards. Flaring of tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.

B. General requirements for couplings, adapters, and standard fittings:

1. Full-flow type, compatible with ASTM B75 or B88 CTS grooved joints.
2. Flaring of tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.

C. Couplings:

1. Material: Cast of ductile iron conforming to ASTM A536, Grade 65-45-12 or ASTM A395 Grade 65-45-15, coated with suitable enamel or epoxy.Constructed of two-piece housing attached with bolts and nuts with pressure responsive elastomeric gasket, with pressure rating of 300 PSI at 180F. Provide washers where required by the manufacturer.

2. Rigid Type:

a. Anvil International Gruvlok Series # 6402.
b. Shurjoint Piping Products Styles #305, #306, and #307.
c. Victaulic Style # 607.

3. Bolts, nuts, and washers:

a. Track-head bolts of heat treated carbon or manganese steel conforming to ASTM A183 or A449 with a minimum tensile strength of 110,000 psi.
b. Heavy-duty hexagonal nuts conforming to ASTM A563, Grade B.

c. Plated carbon steel flat washers conforming to ASTM F436.
d. Zinc-electroplated conforming to ASTM B633.
e. Type 304 or 316 stainless steel bolts and nuts conforming to ASTM A193, Grade B8/B8M, Class 2 or ASTM F593 and F594, Group 2, Condition CW.
f. Type 304 or 316 stainless steel washers.

D. Flange Adapters:

1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).
2. Material: Cast of ductile iron conforming to ASTM A536, Grade 65-45-12 or ASTM A395 Grade 65-45-15, coated with suitable enamel or epoxy.
3. 2 inch-6 inch (ANSI class 125/150):

a. Anvil International Gruvlok Series # 6084.
b. Shurjoint Piping Products Styles # C341.
c. Victaulic Style # 641.

E. Fittings:

1. Materials:

a. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.
b. Lead free bronze sand cast conforming to ASTM B584 alloy UNS C89836.

F. Gaskets:

1. EPDM Gaskets:

a. Grade “E”, “EHP” or “EHT” EPDM compound (green or red/green color coded, respectively) conforming to ASTM D2000 designation 2CA615A25B24F17Z.
b. Temperature operating range: -30 degrees F to +230 degrees F.
c. Style suitable for the application.

2. Fluoroelastomer Gaskets

a. Fluoroelastomer compound specifically formulated for compatibility with potable water systems resistant to chlorine and chloramine disinfectants (red and blue stripe color code).
b. Temperature operating range: 0 degrees F to +180 degrees F.
c. Style suitable for the application.

G. Valves:

1. Provide valves as specified in Division 22 section “General Duty Valves for Plumbing Piping.”

H. Adapters – Grooved X Plain Copper

1. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100. CTS grooved end x plain end for press or sweat connection.

a. Anvil International Gruvlok Series #652
b. Shurjoint #C52

2.3 PRESS TO CONNECT COPPER TUBING SYSTEM

A. Copper Tube:

1. CTS ½inch through 4inch: ASTM B-88 Type K or L.

B. General requirements for couplings, adapters, and standard fittings:

1. Acceptable body materials:

a. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.
b. Cast copper conforming to ASTM B584 alloy C87600 or C84400.

2. Coupling and fitting housings with soldered ends shall conform to ASME B16.18 and B16.22.
3. Coupling and fitting housings with flared ends shall conform to ASME B16.26.
4. Coupling and fitting housings with threaded ends shall conform to ASME B1.20.1.
5. Coupling and fitting housings for press ends shall have self-contained O-ring seals in the coupling/fitting ends.
6. Rated for 200 psi CWP up to 250 degrees F maximum.

C. O-Ring Seals: EPDM compound conforming to ASME B16.51, style suitable for the application.

D. Flange Adapters:

1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).
2. 2-1/2 inch through 4 inch (ANSI class 125/150):

a. Steel flange with NSF 14 compliant fused epoxy coating, copper or brass press to connect joint with copper face ring and plastic or rubber dielectric isolating ring separating the flange from the press to connect joint.

3. Rated for 200 psi CWP up to 250 degrees F maximum.

E. Valves:

1. Provide 2 inch and smaller press to connect valves listed in this section or lead free cast bronze valves 2 inch and smaller listed in Division 22 section “Water Distribution Piping and Specialties” may be used with sweat connections or sweat X press adapters.
2. Ball Valve:

a. Rated for 200 psi CWP up to 250 degrees F maximum, conforming to MSS SP-110.
b. Body and trim: Lead free cast bronze conforming to ASTM B62 or B584.
c. Ends: Female press to connect ends of copper material.
d. Ball: Full port, chrome-plated brass ball.
e. Stem: Blow-out proof, of material silicon bronze conforming to ASTM B371 or ASTM B99, or stainless steel.
f. Seat: PTFE or TFE, suitable for intended service.
g. Operator: Lever handle with non-thermal conductive material for insulated piping. Provide with 2 inch extended sleeve to allow valve operation without disturbing the insulation and with memory stop for throttling, metering or balancing service.

1) Apollo # 77WLF
2) NIBCO # PC-585-LF
3) Milwaukee # UPBA-450-12

3. Ball Valve:

    a. Rated for 200 psi CWP up to 250 degrees F maximum, conforming to MSS SP-110.
    b. Body and trim: Lead free cast bronze conforming to ASTM B62 or B584.
    c. Ends: Female press to connect ends of copper material.
    d. Ball: Full port, stainless steel ball.
    e. Stem: Blow-out proof, of material silicon bronze conforming to ASTM B371 or ASTM B99, or stainless steel.
    f. Seat: PTFE or TFE, suitable for intended service.
    g. Operator: Lever handle with non-thermal conductive material for insulated piping. Provide with 2 inch extended sleeve to allow valve operation without disturbing the insulation and with memory stop for throttling, metering or balancing service.
    h. 2 inch and smaller:

        1) Apollo # 77WLF-140
        2) NIBCO # PC-585-66-LF
        3) Milwaukee # UPBA-450S-12
        4) Viega # 2971.1 ZL

4. Gate Valves

    a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
    b. Body and trim: Lead free cast bronze body conforming to ASTM B62 or B584 with threaded bonnet and solid wedge.
    c. Ends: Female press to connect ends of copper or brass material.
    d. Stem: Silicon bronze conforming to ASTM B371 or ASTM B99, or stainless steel, rising type with brass packing gland and non-asbestos packing.
    e. Operator: Malleable or ductile iron hand-wheel.
    f. 2 inch and smaller:

        1) Apollo # 101T-PRLF
        2) Hammond # UP645 P2
        3) Milwaukee UP105 P2
        4) NIBCO # PC-113-LF

5. Check Valves (Y pattern, swing type or in-line)

    a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
    b. Body and trim: Cast bronze conforming to ASTM B62.
    c. Disc: PTFE renewable seat and disc.
    d. Ends: Female press to connect ends of copper or brass material.
    e. 2 inch and smaller:

        1) Apollo # 163T-PRLF
        2) Hammond # UP904 P2
        3) NIBCO # PF-413-Y-LF

6. Milwaukee # UP509 P2 Check Valves (lift type, in-line)

    a. Rated for 250 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
    b. Body: Cast bronze conforming to ASTM B584.
    c. Spring: 316 stainless steel.
    d. Ends: Female press to connect ends of copper or brass material.
    e. 2 inch and smaller:

1) Apollo # 61LF
2) Milwaukee # UP548T P2

7. Gate Valves -2-1/2 inch and Larger

a. MSS SP-70; Class 125, 200-psi CWP, iron body, bronze mounted, with body and bonnet conforming to ASTM A 126 Class B; with flanged ends, non-asbestos composition packing, and two-piece packing gland assembly. Provide with factory installed press to connect flange adapters, as described herein, with bolts, nuts and washers.

1) NIBCO

F. Strainers:

1. Provide 2 inch and smaller press to connect strainers listed in this section or lead free cast bronze strainers 2 inch and smaller listed in Division 22 section “Basic Piping Materials and Methods” may be used with sweat connections or sweat X press adapters.
2. Strainers (Y pattern)

a. Rated for 250 psig CWP up to 250 degrees F maximum.
b. Body: Cast bronze conforming to ASTM B584.
c. Screen: Stainless steel mesh with 0.062” perforations.
d. Ends: Female press to connect ends of copper or brass material.
e. 2 inch and smaller:

1) Apollo # 59LF

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Install pipe, fittings, valves and specialties in accordance with manufacturer’s installation instructions.

B. Water distribution piping installations shall be installed subject to Division 22 Section “Water Distribution Systems and Specialties” in addition to those requirements specified in this Section.

C. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

3.2 PIPE APPLICATIONS ABOVE GRADE

A. Water piping in sizes 2-1/2 to 8 inches shall be Type L drawn copper tube with roll-grooved ends and copper tube dimensioned mechanical couplings and fittings or water piping sizes 2-1/2 inch to 4 inch shall be Type L drawn copper tube with plain ends and copper tube dimensioned press to connect fittings.

B. Water piping in sizes 2 inches and smaller shall be Type L drawn copper tube with plain ends and copper tube dimensioned press to connect copper couplings and fittings.

3.3 HANGERS AND SUPPORTS

A. Support of piping must account for expansion and contraction, vibration, and the dead load of the piping and its contents.

B. General: Hanger supports, and anchors devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping." Reference Division 22 Section “Water Distribution Systems and Specialties” for pipe spacing limitations.

3.4 PIPE JOINT CONSTRUCTION

A. Copper Grooved tubing System

1. Pipe ends shall be clean and free from oils, indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
2. Roll and cut groove ends in accordance to manufacturer’s current listed standards. Use rolls sets designed and intended for use on the appropriate pipe material when grooving pipe.
3. Flaring of CTS tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.
4. Verify the gasket style and elastomeric material (grade) is suitable for the intended service as specified and in combination with any system chemical additive.
5. Reference latest published manufacturer’s product data for additional pressure ratings and application information.
6. Reference latest published manufacturer’s field installation instructions or other included installation instruction prior to attempting assembly.
7. Ream, deburr and clean tube ends and verify they are free from indentations, projections and roll marks in the area from tube end to groove for proper gasket sealing.
8. All grooved components (couplings, fittings, valves, gaskets, bolts and nuts) shall be of one manufacturer. All grooving tools shall be of one manufacturer, though not necessarily the same as the grooved component manufacturer.
9. Install gaskets with lubricant suitable for all piping services. Lubricant shall be by one manufacturer.

B. Press to connect Copper Tubing System

1. Ream, deburr and clean tube ends and verify they are free from indentations, projections, burrs and foreign matter.
2. Install permanent inspection mark on tube.
3. Clean tube and fittings of all dirt and oil. Verify O-ring is in place and free of oil, grease or dirt.
4. Push copper tube into fittings with twisting action to all the way to the fitting stop or shoulder.
5. Mark tube with permanent marker to indicate proper tube insertion depth.
6. Verify press tool has correct size jaw set for tube size used.
7. Complete one tool cycle with empty jaw to calibrate tool for each time new jaw is inserted into tool.
8. Squeeze jaw arms to open tool jaws and place jaws around the contour of the fitting. Verify tool is perpendicular to the fitting and depress tool switch.
9. Squeeze jaw open to remove the tool and observe witness mark.
10. Verify crimped fitting connection for misalignment of the copper tube, misalignment of the tool or improper insertion of the tube. If any of these conditions are found cut out the joint and provide a new joint.
11. Maintain minimum distance between joints per the manufacturer’s published installation instructions.

C. Dielectric Isolation Requirements for Copper Grooved Connections: Provide dielectric grooved waterway fittings or couplings at grooved galvanized steel, stainless steel or ductile iron to

grooved copper joints. Dielectric waterway fittings are specified in Section “Basic Piping Materials and Methods”.

D. Dielectric Isolation Requirements for Press to Connect Adapter Flange Connections: Provide dielectric flanges or flange kits for the following joint types:

1. Adapter Flanges to Iron, Ductile Iron or Steel Body Valves and Fittings (Except Butterfly Valves with EPDM Sleeve/Seats): Provide full face gaskets between flanges and adapter flanges. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on valve and adapter flanges.
2. Adapter Flanges to Butterfly Valves with EPDM Sleeve/Seats in Series with Iron, Ductile Iron or Steel Body Valves and Fittings: At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on adapter flange. Provide steel bolts on butterfly valve flange.
3. Adapter Flanges to Butterfly Valves in Copper Tubing: Install flat washers at each bolt on adapter flange. Provide full face gasket only for butterfly valves without integral liner acting as a gasket.
4. Full face gaskets, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves are specified in Section “Basic Piping Materials and Methods”.

E. Flange Adapters:

1. Install flange adapter washers when flange adapters are used against the following surfaces:

a. Rubber.
b. Adapting to ANSI/AWWA cast flanges.
c. Rubber faced lug valves.
d. Serrated flanged surfaces.

2. Do not install flange adapters for applications that incorporate tie rods for anchoring or on standard grooved-end fittings within 90 degrees of each other.

3.5 VALVE APPLICATIONS

A. Reference Division 22 Section “Water Distribution Piping and Specialties” for valve applications.

3.6 EQUIPMENT CONNECTIONS

A. Grooved flexible style couplings may be used at equipment connections where specified for vibration isolation control only.

B. Press to connect joints shall not be provided for equipment connections. Provide flanges, unions, di-electric unions or waterway fittings. Flanges, unions, di-electric unions and waterway fittings are specified in Division 22 specification section “Basic Piping Materials and Methods”

3.7 EXPANSION JOINTS:

A. Provide expansion joints where indicated. Expansion joints and their installation requirements are specified in Division 22 specification section “Expansion Fittings and Loops for Plumbing Piping”.

1. Provide with copper press to connect ends or copper press to connect X screwed NPT adapters for 2 inches and smaller.

2. Provide with copper press to connect ends or press to connect adapter flanges for 2-1/2 inches to 4 inches.
3. Provide copper grooved adapter flanges for 2-1/2 inches to 8 inches.

B. Where field conditions allow and as a contractor's option, provide expansion joints consisting of an assembly of flexible couplings: Fabricated from a combination of couplings and nipples with rolled groove short type "K" or "L" copper tube nipples and flexible CTS couplings. Install with removable ties to hold joint compressed or expanded during piping fabrication. Provide the same gaskets as specified above for rigid couplings. Provide expansion joints of an assembly of flexible couplings with displacement identical expansion joints as indicated.

3.8 STRAINERS

A. Provide strainers as specified in part 2 of this specification section or Division 22 specification section "Basic Piping Materials and Methods".

1. Provide manufacturer strainer with press to connect ends for 2 inches and smaller.
2. Provide copper press to connect X screwed NPT adapters for 2 inches and smaller.
3. Provide press to connect adapter flanges for 2-1/2 inches to 4 inches.
4. Provide copper grooved adapter flanges for 2-1/2 inches to 8 inches.

3.9 WATER DISTRIBUTION SPECIALTIES INSTALLATION

A. Reference Division 22 Section "Water Distribution Systems and Specialties" for water distribution specialties and installation requirements.

3.10 FIELD QUALITY CONTROL

A. The following procedures are paraphrased from the ASME B-31.9, code for pressure piping, building services piping.

B. Installing contractor shall schedule training session with the grooved or press to connect manufacturer for all workers that will be installing or handling the grooved or press to connect piping systems. Submit certification letter along with list of attendees to engineer of record within 30-days of mobilization. Include copy of certification letter with closeout documents.

C. Grooved and Press to connect fitting manufacturer shall provide certification training to contractor without cost and without additional cost to Owner.

D. Provide testing procedures as defined in Division 22 Section "Water Distribution Systems and Specialties" and as specified in grooved mechanical piping manufacturer's installation instructions.

E. Installing contractor shall visually inspect couplings and repair or replace any misaligned couplings and couplings with gaps prior to calling for inspection as defined in Division 22 Section "General Plumbing Requirements."

F. Grooved and Press to connect fitting manufacturer's representative shall make periodic visits to the jobsite during construction to ensure the installing contractor is following the latest published manufacturer's field installation instructions and best practice procedures provided during the training session.

3.11 STARTUP

A. Refer to Division 22 Section "Water Distribution Piping and Specialties" for startup procedures.

END OF SECTION 221111

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SECTION 221112 - PEX WATER DISTRIBUTION SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes domestic cold water, hot water, and hot water recirculation tubing, fittings, and specialties within the living units of the building.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section "Joint Sealers," for materials and methods for sealing tube penetrations through basement and foundation walls, and fire and smoke barriers.
2. Division 22 Section "Identification, for Plumbing Tubing and Equipment" for labeling and identification of water distribution tubing.
3. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations and wall penetrations.
4. Division 22 Section "Basic Tubing Material and Methods," for materials and methods for strainers, flexible connectors and mechanical sleeve seals.
5. Division 22 Section "Hangers and Supports for Plumbing Tubing," for insulation shields, materials and methods for hanging and supporting water distribution tubing.
6. Division 22 Section "General Duty Valves for Plumbing Tubing," for materials and methods for installing water distribution tubing valves.
7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution tubing.
8. Division 22 Section “Water Distribution Tubing and Specialties” for copper tubing for water distribution tubing.

1.2 DEFINITIONS

A. Water Distribution Tube: A tube within the building or on the premises that conveys water from the water service tube or meter to the points of usage.

B. Tube sizes used in this Specification are nominal tube size (NPS).

C. Lead Free: Refers to the wetted surface of tube, fittings and fixtures in potable water systems that have a weighted average lead content less than or equal to 0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following codes:

1. ASTM E84 - Surface Burning Characteristics of Building Materials.
2. ASTM F877 Standard Specification for Cross-linked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
3. ASTM F1807 Standard Specification for Insert Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing
4. ASTM F2023 Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water
5. ANSI/NSF Standard 14 Plastics Tubing System Components and Related Materials
6. ANSI/NSF Standard 61 Drinking Water System Components - Health Effects
7. Plastics Tube Institute (PPI) Technical Report TR-4/06

8. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of brass or bronze fittings containing no more than 0.25% lead by weight for domestic water distribution.
9. Comply with the Plastics Tube Institute (PPI) “Residential PEX Water Supply Plumbing Systems Design Guide” and the manufacturer’s installation guide for installation of PEX tubing, including methods for dealing with thermal expansion.

B. PEX tubing, fittings and crimp rings shall be by one manufacturer assembled with the manufacturer’s approved crimping tools.

C. Comply with NSF 61 Annex G for wetted surfaces of fittings containing less than or equal to 0.25% lead by weight compliance for use in domestic water service.

D. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

1. Product data for each tubing specialty and valve specified.
2. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
3. Maintenance data for each tubing specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
4. Test reports specified in Part 3 of this Section.

B. Submit third party certification that fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

C. Tubing and fittings shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

1.5 COORDINATION

A. Reference Division 22 Section “Water Distribution Tubing and Specialties” for coordination.

1.6 SPARE PARTS

A. Maintenance Stock: Furnish the following for each system component:

1. One complete crimping/expander tool set with crimp dies for each tube size.
2. One tube cutter.
3. (6) fittings, tees, els and couplings and required number of crimp rings for all installed tube sizes

1.7 WARRANTY

A. Piping system warranty shall apply to potable water distribution and water service systems constructed of pipe and fitting products sourced from the same manufacturer.

B. Manufacturer system warranty shall cover pipe and fittings for a duration of 25 years, from the date of installation.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Manifolds & Fittings:

   a. Viega “Ultra Tubing”
   b. Watts “WaterPEX”

2. Plumbing Tube Support Brackets

   a. Holdrite
   b. Sioux Chief

3. Polyethylene Cross-Linked (PEX) Tubing System

   a. Viega
   b. Watts “WaterPEX”

2.2 TUBE MATERIALS, GENERAL

A. Tube and Tube: Refer to Part 3, Article "Tube Applications", for identification of systems where the materials listed below are used.

B. PEX Tube: ASTM F877, SDR 9 PEX Water Tube with a pressure rating of 160psi at 73°F and blue or red color coded and listed to NSF-pw (CL5) chlorine resistance rating of 100% use at 140F operating temperature and marked “5306”. Manufactured utilizing the PEX “B” method. NSF 14 certified and NSF 61 listed.

1. Factory vinyl or polyethylene corrugated sleeve for PEX tubing for underground installation.

2.3 MANIFOLDS:

A. Spun copper manifold with line size body with ½” copper sweat outlets and two piece full port bronze ball valves with ½” PEX hose barb outlets.

2.4 FITTINGS

A. PEX Hose Barb Fittings: ASTM 1807 lead free brass or bronze fittings for use with PEX tubing with copper crimp ring.

B. PEX Hose Barb Fittings: ASTM F2159 polysulfone, NSF 14 certified and NSF 61 listed, for use with PEX tubing with copper crimp ring.

C. Stub Out Els: Square “O” strap ASTM B 88 type “L” line size copper tube with 90° bend and line size PEX hose barb inlet.

2.5 TUBE SUPPORT BRACKETS:

A. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of holes of ¾” or 1” on 4” centers.

B. Tube Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent tube in wall.

1. Brackets for installation in return air plenums shall meet ASTM E84.

2.6 GENERAL-DUTY VALVES

A. General-duty valves 2” and smaller (i.e., gate, globe, check and ball valves) are specified in Division 22 Section "General Duty Valves for Plumbing." Provide valves of make and model specified in Division 22 Section "General Duty Valves for Plumbing" with factory PEX hose barbs or provide lead free brass or bronze copper sweat X PEX hose barb adapters.

B. General-duty valves 2-1/2” and larger (i.e., gate, globe, check and ball valves) are specified in Division 22 Section "General Duty Valves for Plumbing."

C. Special duty valves (i.e. T & P, flow control, pressure reducing and thermostatic mixing valves) are specified are specified in Division 22 Section "Water Distribution Tube and Specialties.”

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install tubing and specialties in accordance with manufacturer’s installation instructions.

3.2 TUBE APPLICATIONS

A. Install PEX tubing and manifolds within the living unit mechanical closets in accessible location. Connect PEX tubing to bronze shutoff valve located inside living unit.

B. Install PEX tubing for hot and cold water tubing 2” and smaller. Maximum allowable fluid velocity is 8 feet per second. Provide equivalent SDR 9 PEX tubing nominal diameter to copper type “L” tube nominal (to provide equivalent internal diameters) as shown on the drawings:

Type “L” copper Tube Size (inches)	SDR 9 PEX Tubing Size (inches)
1	1-1/4
1-1/4	1-1/2
1-1/2	2
2	2-1/2
2-1/2	3

C. Install PEX tubing for hot and cold water tubing 2” and smaller in guest tower or dwelling tower. Maximum allowable fluid velocity is 4 feet per second. Provide equivalent SDR 9 PEX tubing nominal diameter to copper type “L” tube nominal (to provide equivalent internal diameters) as shown on the drawings:

Type “L” copper Tube Size (inches)	SDR 9 PEX Tubing Size (inches)
1	1-1/4
1-1/4	1-1/2

1-1/2	2
2	2-1/2
2-1/2	3

D. Install PEX tubing for underground water service tubing and service riser tubing 3” and smaller with one continuous piece of PEX tubing with no joints from the water meter to the shutoff valve at the water service riser. Provide with factory vinyl or polyethylene sleeve at penetration of concrete slab. Provide 1” thick flexible elastomeric insulation at slab penetration, length of slab penetration. Flexible elastomeric insulation and installation requirements are specified in Division 22 specification section “Plumbing Insulation”. Provide 1” thick flexible elastomeric insulation at cold water slab penetration, length of slab penetration. Flexible elastomeric insulation and installation requirements are specified in Division 22 specification section “Plumbing Insulation”.

E. Install PEX tubing for under slab cold, hot and hot water recirculation water tubing with one continuous piece of PEX tubing with no joints from the shutoff valve above grade to the shutoff valve at the fixture served. Provide cold water tubing with factory vinyl or polyethylene sleeve at penetration of concrete slab. Provide 1” thick flexible elastomeric insulation for under slab hot and hot water recirculation tubing. Flexible elastomeric insulation and installation requirements are specified in Division 22 specification section “Plumbing Insulation”.

F. Install type “L” copper tube at the inlet and outlet of the water heater, minimum 18” long. Refer to Division 22 Section “Water Distribution Tubing and Specialties” copper tubing.

G. Install PEX tubing meeting ASTM E84 for 25 / 50 smoke flame rating per manufacturer’s installation instructions inside return air plenums.

H. Install copper tubing for hot water tubing operating in excess of 140ºF. Refer to Division 22 Section “Water Distribution Tubing and Specialties” copper tubing.

3.3 TUBING INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the tubing systems. Location and arrangement of tubing layout take into consideration tube sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install tubing as indicated.

B. Use fittings for all changes in direction and branch connections.

C. Install tubing at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Conceal all tube installations in walls, tube chases, utility spaces, above ceilings, unless indicated to be exposed to view.

E. Install horizontal tubing as high as possible allowing for proper slope and coordination with other components. Install vertical tubing tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of tubes parallel to each other, spaced to permit applying full insulation and servicing of valves.

G. Install tubing in a manner to prevent stress from thermal expansion with 12” wide offsets in straight runs over 20’ or with loops with diameters not less then 8 tube diameters.

H. Install nailing plate over all stud penetrations of studs.

I. Install tubing level with no pitch.

J. Install tubing at rough-in for plumbing fixtures with stub out els.

K. Install line size manifolds above ceilings in an accessible location where indicated on the drawings with hot water on the left and cold water on the right. Provide access doors for manifolds.

L. Install blue tubing for cold water and red tubing for hot or hot water recirculation.

M. Install PEX tubing at a minimum of 12” away from recessed light fixtures.

N. Install PEX tubing below slab with manufacturer’s factory protective vinyl or polyethylene sleeve, full length and provide polyethylene shrink wrap over brass fittings.

O. Install PEX tubing from underground thru slab with manufacturer’s factory protective vinyl or polyethylene sleeve, thru full length to 6” below and above slab.

P. Provide line size stub out els at each fixture rough-in.

1. Secure stub out els at rough-in for individual fixtures with sheet stud brackets attached to the wall studs.
2. Secure stub out els at rough-in for flush valve fixtures with wood backboards attached to the wall studs.

Q. Connect PEX tubing to copper tubing with lead free brass or bronze copper sweat X PEX hose barb adapters.

R. Install PEX tubing, hangers, fittings and adapters, and provide recommended methods for controlling thermal expansion in hot water tubing for straight runs every 50’ per the Plastics Tube Institute (PPI) “Residential PEX Water Supply Plumbing Systems Design Guide” and the appropriate installation guide of the installed PEX manufacturer.

3.4 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to manufacturers published recommendations. Conform to the table below for maximum spacing of supports.

B. Tube Attachments: Install the following:

1. Clamps, designed specifically for use with PEX tubing for installation inside walls.
2. Tube insulators, designed specifically for use with PEX tubing.
3. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs of insulated PEX tubing.
4. Plastic coated adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs of uninsulated PEX tubing.
5. Plastic coated riser clamps, MSS SP-69 Type 8, for individual vertical runs bearing on uninsulated PEX tubing.
6. Insulation protection shields and high density insulation at each hanger for insulated tube as specified in Division 22 Sections “Supports and Anchors” and “Plumbing Insulation”.

C. Install hangers for unsupported horizontal tubing every 32” with 3/8” rods.

D. Provide riser clamps every 6’-0” for vertical PEX tubing.

E. Provide clamps, specifically designed for use with PEX tubing, every 6’-0” for installation inside walls.

F. Contractor’s option: Provide “vee bottom” clevis hangers and “vee” plastic tube support channels of 18 gauge galvanized steel to support horizontal runs of PEX tubing. Provide hangers spaced every 8’-0” with 3/8” rods.

G. Support water tubing within 12” of each elbow, tee or stub out el.

3.5 TUBE AND TUBE JOINT CONSTRUCTION

A. Tubing Joints: Comply with the manufacturer’s published installation instructions and use installation tools and materials by one manufacturer only – do not mix different manufacturers tools and materials.

3.6 INSULATION

A. Insulate hot water and hot water return tubing as specified in Division 22 Section “Plumbing Insulation.” Cold water tubing need not be insulated.

3.7 INSTALLATION OF VALVES

A. Installation of general duty valves is specified in Division 22 Section "General Duty Valves for Plumbing Tubing."

B. Installation of special duty valves is specified in Division 22 Section "Water Distribution Tube and Specialties.”

3.8 FIELD QUALITY CONTROL

A. Inspections: Inspect water distribution tubing as follows:

1. Do not enclose, cover, or put into operation water distribution tubing system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

    a. Rough-in Inspection: Arrange for inspection of the tubing system before concealed or closed in after system is roughed in and prior to setting fixtures.
    b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
    c. Reinspections: Whenever the plumbing official finds that the tubing system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
    d. Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.

B. Tubing System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new water distribution tubing systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution tubing until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
3. Cap and subject the tubing system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the tubing system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.9 ADJUSTING AND CLEANING

A. Clean and disinfect water distribution tubing as follows:

1. Purge all new water distribution tubing systems and parts of existing systems that have been altered, extended, or repaired prior to use.
2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:

    a. Flush the tubing system with clean, potable water until dirty water does not appear at the points of outlet.
    b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.
    c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
    d. Following the allowed standing time, flush the system with clean, potable water until chlorine does not remain in the water coming from the system.
    e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.

3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

3.10 COMMISSIONING

A. Fill the system.

B. Before operating the system, perform these steps:

1. Open valves, stops and faucets to full open position.

END OF SECTION 221112

SECTION 221115 - CPVC WATER DISTRIBUTION SYSTEMS AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes CPVC domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties above floor within the building.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
2. Division 22 Section "Identification, for Plumbing Piping and Equipment" for labeling and identification of water distribution piping.
3. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.
4. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, and mechanical sleeve seals.
5. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.
6. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials and methods for hanging and supporting water distribution piping.
7. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.

1.2 DEFINITIONS

A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.

B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.

C. Pipe sizes used in this Specification are nominal pipe size (NPS).

D. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

1. Product data for each piping specialty and valve specified.
2. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
3. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
4. Test reports specified in Part 3 of this Section.
5. Shop drawings: Detail fabrication for expansion loops, indicating dimensions, weights, required clearances, and methods of assembly of components. Detail fabrication of pipe anchors, pipe alignment guides, hangers, special pipe support assemblies and their

attachment to the building structure. Provide CPVC joint samples cut longitudinally along the joint to verify proper solvent weld technique. Joints to be specified by the engineer at time of site observation.

6. Submit materials in contact with CPVC piping system that are compatible with CPVC compounds per the Lubrizol “FBC System Compatibility Program”.
7. Submit certification that specialties and fittings for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372.
8. Submit contractor certificates indicating completion of CPVC installation training course from manufacturer of piping to be used.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with ASME B31.9 "Building Services Piping" for materials, products, and installation.

B. Comply with the installation requirements for CPVC pipe per the Lubrizol “FlowGuard Gold and CORZAN Design and Installation Manual” and the installed manufacturer’s installation manual.

C. Ensure materials in contact with CPVC piping system are compatible with CPVC compounds per the Lubrizol “FBC System Compatibility Program”. Approved products shall have the FBC™ logo. Go to www.lubrizol.com/CPVC/FBC-System-Compatible-Program.

D. Obtain installation training from the CPVC manufacturer for all workers that will be installing or handling the CPVC piping systems. Submit certification letter along with each workers certificate of completion to engineer of record within 30-days of mobilization. Include copy of certification letter with closeout documents.

E. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. “CORZAN” CPVC Pipe and Fittings

1. Georg Fischer LLC
2. IPEX USA LLC
3. NIBCO Inc. (fittings only)

2.2 PIPE AND TUBE MATERIALS, GENERAL

A. “CORZAN” CPVC Pipe (3” to 6”): ASTM F441, schedule 80 pipe with a cell class of 24448 as identified in ASTM 1784. NSF 14 certified and NSF 61 listed. Meeting ASTM E84 for 25 / 50 flame / smoke rating for pipe sizes 6” and smaller.

2.3 FITTINGS

A. “CORZAN” CPVC Fittings (3” to 6”): ASTM F439, schedule 80 socket-type fittings with a cell class of 23447 as identified in ASTM D1784. NSF 14 certified and NSF 61 listed. Meeting ASTM E84 for 25 / 50 flame / smoke rating for pipe sizes 6” and smaller.

2.4 JOINING MATERIALS

A. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

2.5 PIPING SPECIALTIES

A. Unions: Schedule 80 CPVC two piece unions with solvent socket ends.

B. Flanges: Schedule 80 CPVC with 150# bolt pattern meeting ANSI B16.5, with solvent socket ends meeting ASTM F1970 and 150 psi pressure rating at 73F.

C. Couplings: CPVC with solvent socket ends

D. Banded Couplings: CPVC with schedule 80 solvent socket ends X lead free brass female screwed ends with stainless steel bands meeting ASTM D2846.

E. Threaded Adapter fittings: “ChlorFIT®” schedule 80 CORZAN® CPVC with solvent socket ends X 316 SS male/ female NPT threads.

F. Stub-out els: Type “L” copper tube els with 90 degree bend and CPVC CTS female solvent weld sockets.

2.6 GENERAL-DUTY VALVES

A. Provide valves with sweat X CPVC adapters or sweat X press to connect adapter with press to connect X CPVC adapters.General-duty valves 2-1/2” and larger (i.e., gate, globe, check and ball valves) are specified in Division 22 Section "General Duty Valves for Plumbing."

2.7 SPECIAL DUTY VALVES

A. (i.e. T & P, flow control, pressure reducing and thermostatic mixing valves) are specified are specified in Division 22 Section "Water Distribution Piping and Specialties.”

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install piping and specialties in accordance with manufacturer’s installation instructions.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND WATER SERVICE PIPING

A. Pipe Beds for CPVC Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement or fusion process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Division 22 Section “General Plumbing Requirements” for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 “Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications” for additional requirements.

3.3 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Install “CORZAN” CPVC schedule 80 pipe and fittings with solvent cement joints within building for 2-1/2” and larger.

3.4 BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Install “CORZAN” CPVC schedule 80 pipe and fittings with solvent cement joints within building for 1/2” and larger.

3.5 PIPING INSTALLATION

A. Piping installation is described in Division 22 Section Water Distribution Piping and Specialties”

B. Remove lubricating or cutting oils, or other materials incompatible with CPVC compounds, immediately from CPVC pipe. CPVC pipe that shows staining or surface deflection from absorbing lubricating or cutting oils or other materials incompatible with CPVC compounds shall be cut out and replaced.

C. Provide ancillary plumbing products (i.e. fire stops, thread sealants, leak detectors etc.) that are chemically compatible with CPVC compounds. Go to Lubrizol website for material supplier’s recommendations.

3.6 SERVICE ENTRANCE

A. Extend water distribution piping to connect to water service piping, of size and in location indicated for service entrance to building. Water service piping is specified in a separate section of Division 2.

B. Underground exterior water distribution piping to be a depth as required by local conditions, in accordance with authority having jurisdiction’s requirements and at depth no less than 18” below grade.

C. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.

D. Install sleeve and caulk at penetrations through building floor for watertight installation.

E. Install shutoff valve at service entrance inside building; complete with strainer, pressure gauge, and test tee with valve.

F. CPVC Schedule 80 Pipe: Install pipe below ground inside building and to 5’ outside the building. Restrain joints under building slab with concrete thrust blocks.

3.7 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping”. Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable steel clevis hangers, vinyl coated, MSS SP-69 Type 1, for individual horizontal runs.
2. Riser clamps, vinyl coated, MSS SP-69 Type 8, for individual vertical runs.

a. Provide modified pipe couplings at each vertical riser clamp, serving risers that penetrate multiple floors, and rest modified pipe coupling on the riser clamp. Cut coupling in two just above the pipe stop at the socket bottom. Cut the coupling in half longitudinally and solvent weld both halves to the pipe.

3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections “Supports and Anchors” and “Plumbing Insulation”.
4. Extension split ring pipe clamp, MSS SP-69 Type 12, for SCH 80 pipe inside walls and chases for battery fixtures. Secure clamp to the copper tube.

a. Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section “Mechanical Insulation” for requirement for maintenance of the vapor barrier and vapor barrier seal method.

5. Provide roll hangers for individual horizontal runs 100 feet or longer.
6. Provide vibration isolation for piping connected to rotating equipment. Vibration isolators are specified in Division 22 specification Section “Vibration Isolation for Plumbing Piping and Equipment”.

C. Install hangers for horizontal piping with the following maximum spacing and minimum rod sizes:

Nom. Pipe Size - In.	SCH 80 CPVC Pipe Max. Span - Ft.	Min. Rod Dia. - In.
3	4	3/8
3-1/2	4	3/8
4	4	3/8
5	4	1/2
6	4	1/2
8	4	1/2
10	4	5/8
12	4	5/8

D. Support vertical CPVC pipe and tube every six feet, at base of each floor, and provide mid-story guides.

E. Support CPVC SCH 80 pipe and provide relief for thermal expansion in accordance with the Lubrizol “CORZAN” Design and Installation Manual” or other approved manufacturer installation manual.

F. Support water piping within 12” of each elbow or tee and for water piping 2-1/2” and larger at each valve or strainer.

G. Support CPVC SCH 80 pipe above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

3.8 PIPE AND TUBE JOINT CONSTRUCTION

A. Tapered Socket Joints: Cut pipe squarely to accurate length for full penetration into fittings. Remove burrs from ends, solvent clean joining surfaces thoroughly and form all joints in accordance with the pipe manufacturer's recommendations.

B. Threaded Transition Fittings: Do not thread CPVC pipe. Threaded transitions to metal systems must be made with appropriate fittings designed for plastic-to-metal connections. CPVC socket

x lead free threaded brass transition fittings shall be used for threaded transitions to metal pipe. Use of threaded fittings, types of threaded fittings, and thread sealants shall be in strict accordance with manufacturer's requirements and recommendations.

C. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

1. Flanged Joints with Full Pressure Flange Kits: Provide kits at all flanged joints and install 2 piece backing ring furnished with kit.

D. CPVC Tube: Conform to ASTM D2846.

E. CPVC Pipe: Conform to ASTM F439.

F. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

G. Provide banded couplings at CPVC to metallic male screwed piping connections.

3.9 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2 inches and larger, use flanges instead of unions.

3.10 FIELD QUALITY ASSURANCE

A. Installing contractor shall schedule training session with the CPVC manufacturer for all workers that will be installing or handling CPVC piping systems.

B. CPVC piping manufacturer shall provide certification training from factory certified installation trainer to workers without additional cost to Owner. CPVC manufacturer shall provide a certificate letter stating the time, date and location of the training. CPVC piping manufacturer shall provide a certificate of completion to each worker. Contractor shall keep each worker's certificate on site at all times.

C. Workers performing solvent welding of CPVC joints shall initial each joint with a permanent ink marker, such as a "Sharpie". Initials shall be block letters with a minimum height of 1/4".

D. Hydrostatic Tests, Single-Wall Pressure Piping:

1. Test Pressure: One-and-one-half times the working pressure up to the maximum pressure of the lowest pressure-rated appurtenance in the system.

a. DO NOT exceed the maximum rated pressure of the lowest rated appurtenance in the system.
b. DO NOT test pipe, fittings and valves with compressed air or other gases. DO NOT use air-over-water boosters.

2. Fully inspect installed piping for evidence of mechanical abuse and/or suspect joints.

3. Split system into test sections not exceeding 1,000 feet
4. Slowly fill the pipe section with water, at a velocity of 1.0 feet/sec or less.
5. Evacuate any entrapped air from the high points in the system.
6. Allow a minimum of one hour for temperature equilibrium to be achieved in test section before pressurizing.
7. Visually check test section for leaks. If clear, check for and remove any remaining air and increase pressure up to 50 psi.
8. Leave section pressurized for 10 minutes.

    a. If pressure decays, inspect for leaks.
    b. If the pressure remains constant, slowly increase the hydrostatic pressure to one-and - one-half times the nominal working pressure up to the maximum pressure of the lowest pressure-rated appurtenance in the system.

9. Leave the section pressurized for a period not exceeding 1 hour. During this time, the pressure should remain constant.

    a. If there is a significant drop in static pressure or extended times are required to achieve pressure, either joint leakage has occurred or air remains in the line.

        1) Inspect for leakage and if none is apparent, reduce the pressure and check for trapped air.
        2) Trapped air must be removed before further testing.
        3) Repair joint leaks and

            a) Allow solvent welded joints to fully cure before re-pressurizing.

END OF SECTION 221115

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of plumbing pumps:

1. Cartridge type inline circulators
2. Packaged domestic booster pumps

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
2. Division 22 Section “Coordination” for basic requirements for electrical components that are an integral part of packaged system components.
3. Division 22 Section, “Basic Piping Materials and Methods” for rubber flexible connectors.
4. Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for inertia pads, isolation pads, spring supports, and spring hangers.
5. Division 26 Section “Common Work Results for Electrical” required electrical devices.
6. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including standard performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
2. Shop drawings showing layout and connections for plumbing pumps. Include setting drawings with templates, and directions for installation of foundation bolts, anchor bolts, and other anchorages.
3. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.
4. Maintenance data for plumbing pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."
5. Submit certification that pumps, valves, fittings and specialties comply with NSF 61 Annex G.

1.3 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install plumbing pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Plumbing pumps shall be listed and labeled by UL and comply UL Standard 778 "Motor Operated Water Pumps."

D. UL Compliance: Control panels shall be listed and labeled by UL and comply with Standard 508A “Control Panels”.

E. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.

F. Single-Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.

G. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of plumbing pumps is on the proposer.

H. Comply with NSF 61 Annex G (pending) for wetted surfaces of valves, fittings and specialties containing no more than 0.25% lead by weight compliance for valves for domestic water service.

I. Valves, pumps and fittings shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

1.4 WARRANTY

A. Provide warranty as required by spec section 220010.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Cartridge Type Inline Circulators:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett, ITT.
   c. Grundfos Pumps, Corp.
   d. Taco, Inc.

2. Packaged Domestic Booster Pumps:

   a. Advanced Mechanical Technologies
   b. Armstrong
   c. Bell & Gossett, ITT
   d. Canariss Corp.
   e. Delta P Carver
   f. Grundfos Pumps, Corp.
   g. QuantumFlo, Inc.

3. Aquastats:

   a. Dayton
   b. Honeywell
   c. Penn
   d. White-Rodgers

2.2 PUMPS, GENERAL

A. Pumps and circulators: factory assembled and factory tested.

B. Preparation for shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Motors: Conform to NEMA standards; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection and grease-lubricated ball bearings. Select motors that are nonoverloading within the full range of the pump performance curve.

D. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 CARTRIDGE TYPE CIRCULATOR PUMPS

A. General Description: Leakproof, inline, seamless, volute-type pump. Pump and motor shall be assembled on a common shaft in a single hermetically sealed unit, without stuffing boxes or mechanical seals. Accomplish sleeve bearings lubrication by circulating pumped liquid through the motor section. Isolate motor section from the motor stator windings with a thin corrosion-resistant, nonmagnetic, alloy liner. Pumps shall be rated for 125 psig working pressure and 225 deg F continuous water temperature.

B. Casings: Cast lead free bronze, with stainless steel liner and static O-ring seal to separate motor section from motor stator, and with union piping connections.

C. Impeller: Overhung, single-suction, closed or open nonmetallic impeller.

D. Pump Shaft and Sleeve: Stainless steel shaft with carbon steel bearing sleeve.

E. Motors: 1750 RPM one piece sealed type.

2.4 PACKAGED DOMESTIC BOOSTER PUMPS – VARIABLE SPEED

A. Packaged, variable speed type with duplex close coupled pumps, control panel, motors, variable speed drives, gauges, ball or gate type isolation valves, accumulator tank, thermal bleed aquastat and solenoid valve and accessories. The packaged system, including all items listed below, shall be factory assembled on a fabricated steel base plate with structural steel framework. The completed package shall be factory tested, adjusted and certified for the specified flow conditions, and shipped as an integral unit ready for plumbing and electrical connections.

B. Pumps: Provide single stage end suction type with close-coupled motors, mechanical seals, and stainless steel volute with stainless steel impeller. Pump shall be lead free design without wear ring.

C. Pumps: Provide single stage end suction type with close-coupled motors, mechanical seals, and cast iron volute and impeller. Pump shall be lead free design without wear ring.

D. Motors: Provide variable speed open drip proof type, operate at 3500 rpm and shall not overload at any point of the pump curve.

E. Check Valves on discharge side of pump: Class 150, iron body wafer type; with replaceable Buna-N bonded bronze seat, and non-slam design with bronze disc and stainless steel spring.

F. Piping: Suction and discharge headers shall be 316 stainless steel with ANSI class 150 pressure rating and flanges welded to the headers. Peak velocity in headers shall not exceed 8 feet per second. Furnish with the following valves:

a. Lead Free Ball Valves, 2 Inch and Smaller: Meeting MSS SP-110, Class150, 600-psi CWP; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof stem and chrome-plated lead free brass ball, with replaceable "Teflon" or "TFE" seats and seals, solder ends and vinyl-covered steel handle.
b. Lead Free Lift Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 300-psi CWP, body, disc holder and cap of ASTM B 584 cast lead free bronze; horizontal or angle pattern, lift-type valve, with stainless steel spring, renewable "Teflon" disc and solder ends. Provide valves capable of being refitted and ground while the valve remains in the line.

c. Butterfly Valves, 2-1/2-Inch and Larger: MSS SP-67; 200-psi CWP; lug-type body constructed of cast-iron conforming to ASTM A 126, Class B or ductile iron conforming to ASTM A 536. Provide valves with field replaceable EPDM sleeve/seat, aluminum-bronze disc, 416 stainless steel stem, and EPDM O-ring stem seals. Provide lever operators, (10 position minimum), with lock and stops with locks for sizes 2-1/2 through 6 inches and gear operators with position indicator for sizes 8 inch and larger. Drill and tap valves on dead-end service or requiring additional body strength. Valves must be rated for dead end service at 150 psi with no downstream flange required.

d. Cast Iron Body Ball Valves, 2-1/2” and larger: 200 CWP, maximum operating temperature of 140F; two piece cast iron body meeting ASTM A126 Class B with flanged ends, 304 stainless steel full port ball and shaft, ductile iron handle, PTFE gasket, stem seal and seat.
e. Wafer Check Valves: Class 150, stainless steel; with replaceable seat, and non-slam design lapped and balanced twin stainless steel flappers and stainless steel trim and

torsion spring. Provide valves designed to open and close at approximately one foot differential pressure.

G. Accumulator Tank: Provide tank size as scheduled on the drawings with a minimum pressure rating of 125psig; FDA approved elastomer bladder, tank bottom connection and air charge valve. Tank shall be complete with check valves, isolation valves and pressure reducing valve for remote installation.

H. Controls and Instruments: Control panel shall be mounted on the pump package and shall include a NEMA 1 enclosure, through door fusible disconnect, disconnect for each pump, overload relays and indicator lights, 120V control circuit transformer with primary and secondary fuse protection, low suction pressure limit switch, suction and discharge header pressure sensors, programmable logic controller and variable speed drives. Touchscreen operator interface for monitoring and adjustment of the programmable controller variables with virtual on-off-automatic selector switch for each pump, low suction pressure shutdown alarm, high system pressure shutdown alarm, high flow rate shutdown alarm, pump running indicators and hour meter for each pump. Controls shall be arranged for termination of 1 incoming power feeder. Control panel shall have a unit short circuit current rating equal to or greater than the available short circuit current as indicated on the electrical drawings.

1. Programmable Logic Controller (PLC): Designed specifically for the control of pumps with variable speed drives capable of receiving two analog pressure inputs, analog flow input, automatic pump alternating and On-line field modified data entries for staging pumps, with software memory stored in non-volatile EPROM memory, furnish with user interface keypad with LED display.
2. Alarm Interface: Provide dry contact internal to the control panel for the following alarm conditions:

    a. Low suction pressure shutdown alarm
    b. High system pressure shutdown alarm
    c. High flow rate shutdown alarm

3. Variable Speed Drive: The variable speed drives (VFD) shall be adjustable frequency which employ a pulse width modulated inverter. The drive shall include built in diagnostics. Diagnostics shall be annunciated through the alpha numeric keypad. The drive shall be listed UL, ETL and/or CSA. To insure safety of the equipment, the VFD shall include these protective features and options:

    a. NEMA 1 enclosure.
    b. Static instantaneous over-current and over-voltage trip.
    c. Static over-speed (over-frequency) protection.
    d. Line or fuse loss and under-voltage protection.
    e. Power unit over-temperature protection.
    f. Motor inverse time overload protection.
    g. Input fused disconnect or circuit breaker.
    h. Total voltage harmonic distortion from the VFD shall be less than 5% to meet IEEE requirements.
    i. Speed meter.
    j. Automatic restart after power failure or minor drive fault. The drive shall attempt a minimum of two restarts before a complete drive shut-down.
    k. Power on light.

l. Manual speed potentiometer or control capability through the keypad.
m. Hand/Off/Automatic Switch or Manual/Automatic Switch with start/stop pushbutton.
n. Test switch
o. VFD fault light and reset.
p. Output to the PLC and integral LED display
q. The VFD shall be microprocessor based and utilize digital input for all parameter adjustments. The VFD shall include a digital display for monitoring system parameters and for first fault indication, and digital input programming capability on the main logic board.
r. The VFD shall operate on a frequency range of 1 to 66 Hz with resolution of 0.1% of base speed with analog input or 0.025% with digital input and have accuracy within 0.05% of set point. VFD shall operate in environment of 0 to 40 degrees C, 3,300 feet altitude and 95% non-condensing humidity without derating.
s. All control circuit voltages shall be physically and electrically isolated from power circuit voltages.
t. All VFD's shall be tested/run in the equivalent of NEMA 1 enclosure and burned in at rated ambient (40° C) with a fully loaded motor.

4. Pressure Sensors: NEMA 4 water tight enclosure with pressure rating of 2,000psi, stainless steel wetted parts, 0.25" male NPT connection, calibration from 0 to 150 psi with 4-20mA DC signal at 24 VDC. Refer to the floor plans for location of remote pressure sensor.
5. Sequence of Operation: The domestic water booster pump shall be in automatic mode per the design conditions shown on the booster pump schedule. The pump shall modulate its speed to maintain the discharge head pressure setpoint, as determined by the internal control algorithm, simulating the performance of a system utilizing a remote differential pressure sensor. The pumps shall run in a lead/lag operation based on user defined run-time setpoint. When the flow capacity of the lead pump is exceeded, the lag pump shall start after an adjustable time delay. If the capacity of the lead pump and lag pump is exceeded, the second lag pump (and the N+1 sequencing shall continue based on the number of pumps in the system) shall start.

    a. When a single pump operates at minimum flow rate, the pump speed shall be reduced to the minimum discharge header pressure as scheduled. When required flow increases, the pump speed shall increase linearly to the discharge pressure as scheduled at full flow, simulating the performance of a system utilizing a remote differential pressure sensor.
    b. When the lead pump is stopped because of required zero flow, the pump speed shall increase linearly to the discharge pressure as scheduled to charge the tank, then stop.

6. Safeties:

    a. Low Suction Pressure

        1) When the suction pressure drops below the low suction pressure alarm point as determined by the integral suction pressure sensor, the pumps shall be disabled and an audible alarm shall be sent to the BMS or local building alarm system.

    b. High Discharge Pressure

        1) When the discharge pressure rises above the high discharge pressure alarm point as determined by the integral discharge pressure sensor, the pumps shall be disabled and an audible alarm shall be sent to the BMS or local building alarm system

    c. High Flow Shutdown

1) When the discharge flow, as calculated by the control system, rises above the high flow alarm point, the pumps shall be disable and an audible alarm shall be sent to the BMS or local building alarm system.

7. Control Wire: Domestic booster pump manufacturer shall furnish the appropriate type and amount of wire for interlock of the remote sensors with the domestic booster pump control panel.

I. Startup Services: Domestic booster pump manufacturer shall provide factory start-up and check out of the booster pump. He shall provide the Owner's Representative with certification of proper installation and system operation.

2.5 AQUASTATS:

A. Remote sensing bulb type, non-modulating, single pole double pole throw with surface mount sensing bulb and mounting bracket, adjustable direct reading scale for set point with adjustable differential.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps in accordance with manufacturer's installation instructions.

B. General: Comply with the manufacturer's written installation and alignment instructions.

C. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

D. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

E. Suspend inline pumps with althread hanger rod and vibration isolation hangers of sufficient size to support the weight of the pump independent from the piping system.

3.2 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine rough-in for plumbing piping systems to verify actual locations of piping connections prior to installation.

3.3 CONCRETE EQUIPMENT BASES

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for concrete equipment bases.

1. Form concrete equipment bases by using framing lumber with form release compounds. Chamfer top edge and corners of pad.
2. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves using manufacturer's installation template.
3. Place concrete and allow to cure before installation of pumps.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.

1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."

B. After alignment is correct, tighten the foundation bolts evenly but not too firmly. Fill the base plate completely with nonshrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

1. Alignment tolerances shall meet manufacturers recommendations.

3.5 CONNECTIONS

A. General: Install valves that are same size as the piping connecting the pump.

B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.

C. Install a nonslam check valve and shutoff valve on the discharge side of pumps.

D. Install a gate valve and strainer on the suction side of inline pumps.

E. Install pressure gauge connector plugs in suction and discharge piping around pump. Pressure gauge connector plugs are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."

F. Install surface mounted aquastat on bare metal pipe, fastened securely to pipe upstream of circulator pump when indicated on the drawings.

G. Interlock aquastat and or timer with hot water recirculation pump motor. Electrical wiring and connections are specified in Division 26 section “Common Work Results for Electrical”.

H. Electrical wiring and connections are specified in Division 26 section “Common Work Results for Electrical”.

I. Install domestic booster pump remote sensors as recommended by the manufacturer. Coordinate interlock of the sensors and domestic booster pump. Install control wire furnished with the domestic booster pump for interlock with the sensors. Electrical wiring and connections are specified in Division 26 section “Common Work Results for Electrical”.

J. Install flexible connectors at the header inlet and outlet of domestic booster pump, refer to Division 22 Section “Basic piping Materials and Methods”.

K. Provide equipment pad and vibration isolators, refer to Division 22 Section “Vibration Isolation for Plumbing Piping and Equipment”.

1. Extend equipment pads to 2” beyond elbows, shutoff valves and flexible connectors. Anchor elbows and shutoff valves to equipment pad.

2. Extend equipment pad to 2” beyond base elbows. Anchor elbows to equipment pad. Install flexible connectors and shutoff valves in the vertical. Anchor shutoff valves to the structure.

L. Coordinate interlock of high flow rate, low suction pressure and high discharge pressure level alarms with the building automation system. Alarm wiring and alarm interlock with the building automation system are specified in Division 23 Section “Direct-Digital Control for HVAC”.

3.6 FIELD QUALITY CONTROL

A. Check suction lines connections for tightness to avoid drawing air into the pump.

3.7 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.
2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
2. Open the valve in the cooling water supply to the bearings where applicable.
3. Open the sealing liquid supply valve if the pump is so fitted.
4. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.
5. Open the recirculating line valve if the pump should not be operated against dead shutoff.
6. Start motor.
7. Open the discharge valve slowly.
8. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.
9. Check the general mechanical operation of the pump and motor.
10. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge gate valve open, the steps are the same except that the discharge gate valve is opened some time before the motor is started.

D. Start Up Services for Booster Pump:

1. Certification: Prepare certificates for factory compliance of the installation and completion of factory training signed by the factory-authorized service representative and turn over to the Architect upon completion of the project.

END OF SECTION 221123

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SECTION 221300 - SANITARY DRAINAGE AND VENT PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
2. Division 33 Section "Sanitary Sewage Systems," for sanitary drainage piping beginning from 5'-0" outside the building.
3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
4. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.
5. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
6. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
7. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.
8. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.
9. Division 22 Section “Water Distribution Piping and Specialties,” for material and methods for trap primers and trap primer inlet piping.
10. Division 22 Section “221328 Condensate Pumps for HVAC Equipment,” for material and methods for condensate pumps.

1.2 DEFINITIONS

A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls of the building and conveys it to the building sewer.

B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.

C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

B. Product data for the following products:

1. Drainage piping
2. Drainage piping specialties
3. Floor drains
4. Trench drains
5. Interceptors
6. No-hub fitting restraints

C. Test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Comply with the installation requirements for CPVC pipe and CPVC CTS tube per the Lubrizol “FlowGuard Gold and CORZAN Design and Installation Manual” and the installed manufacturer’s installation manual.

B. Regulatory Requirements: Comply with the provisions of the following codes:

1. 2018 International Plumbing Code

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Drainage Piping Specialties, including backwater valves, expansion joints, cleanouts, floor drains, cast-iron trench drains and vandal-proof vent caps:

a. Jay R. Smith Mfg. Co.
b. Josam Mfg. Co.
c. Mifab Manufacturing Co.
d. Sioux Chief Manufacturing Co. Inc.
e. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
f. Watts Industries, Inc.
g. Zurn Industries, Inc.; Hydromechanics Div.

2. Freeze-proof vent caps:

a. F.J. Moore Mfg. Co.

3. Non-Metallic Trench Drains:

a. ABT, Inc., Polydrain
b. Dura Trench
c. Jay R. Smith Mfg. Co.
d. Mifab Manufacturing Co.
e. MEA-JOSAM
f. NDS
g. Sioux Chief Manufacturing Co. Inc.
h. Watts Industries, Inc.
i. Zurn Industires, Inc.

4. Hydromechanical Grease Interceptors:

    a. Josam Mfg. Co.
    b. Mifab Manufacturing, Inc.
    c. Rockford Sanitary Systems
    d. Jay R. Smith Mfg. Co.
    e. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
    f. Watts Industries, Inc.
    g. Zurn Industries, Inc.; Hydromechanics Div.

5. Plastic Hydromechanical Grease Interceptors:

    a. CANPLAS
    b. Green Turtle, Inc.
    c. Mifab Manufacturing, Inc.
    d. Schier Products

6. Plastic Hydromechanical Sand/Oil Separators:

    a. CANPLAS
    b. Green Turtle, Inc.
    c. Mifab Manufacturing, Inc.
    d. Striem

7. Heavy Duty Hubless Couplings

    a. Anaco Husky HD-2000
    b. Clamp-All 80in. lb.
    c. Ideal Tridon “HD”
    d. ProFlo “HD”
    e. Mission Rubber Company, “Heavy Weight”

8. Cast Iron Soil Pipe and Fittings

    a. AB & I Foundry
    b. Charlotte Pipe and Foundry Company
    c. Tyler Pipe / Soil Pipe Division

9. Shielded Transition Couplings

    a. FERNCO, “Proflex 3000 Series”
    b. Mission Rubber Company, “Band Seal Specialty Couplings”

10. Underground Shielded Adapter Couplings

    a. FERNCO, “1056 Series with SR73 Shear Ring”
    b. Mission Rubber Company, “MR56 Series”

11. Trap Seals

    a. Jay R. Smith Mfg. Co.
    b. Mifab Manufacturing, Inc.
    c. Proset Systems “Trap Guard”
    d. Rector Seal, Inc.
    e. Zurn Industries, Inc.; Hydromechanics Div.

12. Flush Guard

    a. Sage Products LLC “Traptex”

13. Hubless Couplings:

    a. Anaco
    b. Ideal Tridon
    c. Mission Rubber Company
    d. ProFlo “PFNH”
    e. Tyler Pipe / Soil Pipe Division

14. No-Hub Fitting Restraints

    a. Holdrite

15. Backwater Valves

    a. Cleancheck
    b. Mainline Backflow Products
    c. Mifab Manufacturing Co.
    d. Sioux Chief
    e. Spears

16. Heavy Duty Hubless Couplings for Below Slab

    a. Anaco Husky HD-4000
    b. Clamp-All 125in. lb.

17. “Flowguard Gold” CPVC Water Distribution Tube and Fittings

    a. Bow Industrial Corp.
    b. Cresline Plastics Co., Inc. (pipe only)
    c. Genova Products, Inc
    d. Nibco Inc. (fittings only)

2.2 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

A. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, no-hub pipe and fittings and bearing the trademark of CISPI and NSF.

    1. Couplings and compression gaskets, NSF certified: ASTM C564 and CISPI 310.
    2. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.

B. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.

    1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

C. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.

    1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

D. “Flowguard Gold” CPVC Water Distribution Tube (1/2” to 2”): ASTM D2846, Copper Tube Size (CTS), pipe with a cell class of 24448 as identified in ASTM 1784. NSF 14 certified and NSF 61 listed. Meeting ASTM E84 for 25 / 50 flame / smoke rating.

1. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

a. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.3 UNDERGROUND BUILDING DRAIN AND VENT PIPE AND FITTINGS

A. Cast-Iron Soil Pipe: ASTM A74, Service weight, hub-and-spigot soil pipe and fittings. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces and bearing the trademark of CISPI and NSF.

1. Neoprene Compression Gaskets: ASTM C564.

B. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, hubless pipe and fittings and bearing the trademark of CISPI and NSF.

1. Heavy-Duty couplings and compression gaskets: ASTM C564, ASTM C1540 and FM 1680.

C. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with “solid wall” PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
2. Solvent: ASTM D2564.

D. PVC Pressure Pipe and Fittings: Schedule 80 pipe meeting ASTM D1785 with “solid wall” PVC meeting ASTM D1784 with cell class 12454.

1. Solvent: ASTM D2564.
2. Fittings: Schedule 80 meeting ASTM D2467 with solvent cement socket joints.

E. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

2.4 DRAINAGE PIPING SPECIALTIES

A. Backwater Valves: Valve assembly shall be bronze fitted cast-iron, with bolted cover. Flapper shall provide a maximum 1/4 inch clearance between flapper and seat for air circulation. Valve ends shall suit piping material.

B. Expansion Joints: Cast-iron body with adjustable bronze sleeve, bronze bolts with wing nuts.

C. Cleanout Plugs: As specified on the drawings.

D. Floor Cleanouts: As specified on the drawings.

E. Wall Cleanouts: As specified on the drawings.

F. Floor Drains: As specified on the drawings.

G. Trap seals: Provide trap seals meeting either description below:

1. Smooth, soft, flexible, elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom. The flow of wastewater allows duck's bill to open and adequately discharge to floor drain through its interior. The duck's bill closes and returns to original molded shape after wastewater discharge is complete. Or, smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its interior. The flapper closes and returns to original molded shape after wastewater discharge is complete.
2. Smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its opening. The flapper closes and returns to original position after wastewater discharge is complete.

2.5 FLUSH GUARDS

A. Stainless steel device custom fit to approved water closet.

2.6 NO-HUB FITTING RESTRAINTS

A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

2.7 TRENCH DRAINS

A. Trench drain type designations and sizes are indicated on the Drawings.

B. Non-Metallic Trench Drains: Polyester resin and quartz aggregate, precast, interlocking design, with bottom radius and 0.6 percent slope.

1. Precast Material: Load pressure of 14,500 psi, bending pressure of 2,900 psi, frost-proof, salt-proof, inert under dilute acid and alkali conditions, and less than 1.0 percent water absorption rate.
2. Grates: Cast iron or steel as indicated, for heavy-duty truck traffic, with openings designed to prevent entry of bicycle or wheelchair tires.

2.8 INTERCEPTORS

A. Interceptor type designations, flow rates, and capacities are indicated on the Drawings.

B. Hydromechanical Grease Interceptor: As scheduled on the drawings.

C. Hydromechanical Sand/Oil Interceptor: As scheduled on the drawings.

D. Solids Interceptor: As scheduled on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND SANITARY BUILDING DRAINS

A. Pipe Beds:

1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section “General Plumbing Requirements” for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 “Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications” for additional requirements.
2. Cast Iron Soil Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation and maintain continuous pipe slope. For piping with rock trench bottoms, provide sand pipe bed 6” underneath and around sides of pipe, including fittings. After pressure testing is complete, install subbase. Refer to Section ”General Plumbing Requirements” for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.3 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

A. Install hubless, cast-iron soil pipe and fittings for 15” and smaller soil, waste, and vent pipe.

B. Install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings, copper sweat X screwed with solder joints, for waste connections from urinals, lavatories, sinks, water coolers, and kitchen equipment to cast iron drainage piping.

C. Install Type M copper tube with wrought copper fittings with solder joints, 1” and smaller, with ¾” minimum size and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4” and larger for waste connections from kitchen equipment and terminate over floor receptors with air gap.

D. Condensate drain piping and pumped condensate drain piping inside the building: Provide ¾” minimum size or as indicated on the drawings. Slope gravity drainage condensate piping from mechanical equipment at 1/8” per foot minimum slope. Discharge to floor receptor with air gap.

1. Install Type M copper tube with wrought copper fittings with solder joints, 1” and smaller and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4” and larger. Provide galvanic isolators as specified in Division 22 “Basic Piping Materials and Methods”.
2. Install CPVC CTS pipe and fittings, 2” and smaller.

E. Condensate drain piping outside the building: Provide ¾” minimum size or as indicated on the drawings. Slope condensate piping at 1/8” per foot minimum slope to discharge point. Discharge to roof receptors or roof drains with air gap.

1. Install Type M copper tube with wrought copper fittings with solder joints, 1” and smaller, and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4” and larger. Provide galvanic isolators as specified in Division 22 “Basic Piping Material and Methods”.

F. Install type ”L” copper tube with wrought copper fittings with solder joints for sump pump discharge pipe.

G. Install ½” type L copper tube for trap primer outlet piping.

3.4 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

A. Install hub-and-spigot, service weight, cast-iron, soil pipe and fittings with gasketed joints for 15 inch and smaller for soil, waste, and vent pipe.

B. Install hubless, cast-iron soil pipe and fittings 15” and smaller for soil, waste and vent pipe.

C. Upon Owner approval, install PVC Type DWV Plastic pipe and fittings for drainage and vent pipe for 24” and smaller. Install fabricated fittings for 16 inch and larger.

D. Install type ”K” soft copper tube with wrought copper fittings with solder joints for sump pump discharge pipe, 2” and smaller.

E. Install ½” type K soft copper tube for trap primer outlet piping.

3.5 PIPE AND TUBE JOINT CONSTRUCTION

A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."

B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:

1. Install hubless couplings complying with CISPI 310 on soil, waste and vent piping.
2. Install hubless couplings complying with CISPI 310 on and soil and waste piping 3” and smaller and all vent piping.
3. Install heavy duty hubless couplings on soil or waste stacks, soil and waste piping connections to soil or waste stacks and all soil and waste piping 4” and larger.
4. Install No-Hub fitting restraints on joints 5” and larger at:

    a. Changes of direction from vertical to horizontal
    b. 4” branch connections, including tees, wyes and wye combination fittings to soil and waste piping 5” and larger
    c. Horizontal changes of direction 22-1/2 degrees and greater

C. Install heavy duty hubless couplings on hubless soil, waste and vent piping ping below floor.

D. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.

E. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

3.6 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Paint exposed copper drain lines serving kitchen equipment with a minimum of two coats of chromium-base paint.

H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section " Basic Piping Material and Methods" for special sealers and materials.

I. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls using sleeves and mechanical sleeve sealers. Refer to Division 22 Section "Basic Piping Material and Methods" for additional information.

J. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section " Basic Piping Material and Methods" for special sealers and materials.

K. Foundation Penetrations: Where pipes pass through foundation walls above strip footings or under strip footings, protect pipes from building load with cast iron soil pipe sleeves two pipe sizes larger than the pipe. Sleeves installed under the strip footing shall be encased in concrete.

L. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

M. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

N. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

O. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger. Install vent piping pitched to drain back by gravity to the sanitary drainage piping system.

P. Extend building drain to connect to service piping, of size and in location indicated for service entrance to building. Sewer service piping is specified in a separate section of Division 2.

Q. Install 1 inch thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend minimum of 12" beyond each side of pipe. Install directly over, and center on pipe center line.

3.7 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.

    a. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".Install high density insulation on insulated pipe.

3. Provide vinyl coated hangers and riser clamps for use with PVC pipe and CPVC CTS tube.
4. Provide roll hangers for individual horizontal runs 100 feet or longer.
5. Provide ceiling flanges attached to the floor, all thread rod and split ring pipe clamps for indirect drains and condensate drains supported from the floor 2" and smaller.

C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size – In.	Copper Tube Max. Span – Ft.	Min. Rod Dia. - In.
Up to 1-1/4	6	3/8
1-1/2 to 2	10	3/8
2-1/2 to 4	10	3/8
5	10	1/2
6	10	1/2
8	10	1/2
10 to 12	10	5/8
14 to15	N/A	3/4

Nom. Pipe Size In Inches.	CTS CPVC Tube Max. Span - Ft.	CPVC Tube Min. Rod Dia. - In.
1/2	3	3/8
3/4	3	3/8
1	3	3/8

1-1/4	4	3/8
1-1/2	4	3/8
2	4	3/8

1. Support all sizes of service weight horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide sway brace on horizontal piping at not more than 40' intervals to prevent horizontal movement. Provide support at each horizontal branch.
2. Support all sizes of vertical cast iron piping every ten feet.
3. Support all sizes of vertical of PVC / CPVC piping every floor, but not to exceed ten feet. For sizes 2 inches and smaller, provide guide midway between required vertical supports.
4. Support vertical PVC / CPVC pipe and tube every six feet, at base of each floor, and provide mid-story guides.
5. Support piping within 12" of each elbow or tee.
6. Support each P-trap.

D. Support condensate piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table above for maximum spacing of supports. Adjust pipe support to maintain minimum pipe slope.

3.8 INSTALLATION OF PIPING SPECIALTIES

A. Install backwater valves in sanitary building drain piping as indicated, and as required by the plumbing code. For interior installation, provide cleanout cover flush to floor centered over backwater valve cover and of adequate size to remove valve cover for service.

B. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;
3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
4. at base of each vertical soil and waste stack.

C. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.

D. Floor Cleanouts: Install in below floor building drain piping as indicated, and:

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;
3. Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping;
4. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

E. Exterior Cleanouts: Install exterior cleanouts embedded in a 18" x 18" x 8" block of concrete, flush with finished grade.

3.9 INSTALLATION OF FLOOR DRAINS, AND FLOOR SINKS

A. Install floor drains, and floor sinks in locations indicated.

B. Install floor drains and trench drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor. Set floor sinks flush with the level finish floor.

C. Refer to architectural documents for floor slope requirements and set floor drain elevation to match. Where architectural documents do not indicate the requirements, set the floor drain elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

DEPRESSION IN INCHES	RADIUS OF AREA DRAINED - FEET
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

D. Provide P-traps for drains connected to the sanitary sewer.

E. Install floor drains and floor sinks, in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

F. Position drains so that they are level, accessible and easy to maintain.

3.10 INSTALLATION OF TRAP PRIMERS

A. Install trap primer outlet piping with 1/32” per foot slope towards drain trap where possible.

B. Connect trap primer outlet piping only to factory installed taps on the drain body or P-trap assembly or provide an auxiliary inlet fitting with factory installed trap primer tap.

C. Install trap primer outlet piping in elevated slabs or slabs on grade below concrete reinforcing bars. Wrap with ½” thick flexible unicellular insulation, attach to the reinforcing bars with plastic ties and spacers every five feet to eliminate galvanic corrosion. Refer to Division 22 Section "Plumbing Insulation” for flexible unicellular insulation.

D. Where proper trap primer outlet piping slope can be maintained and the trap primer outlet line would not be subject to freezing, trap primer outlet lines may be installed as follows:

1. Install below elevated floor slabs.
2. Install in the sub grade of slab on grade.

E. Install sleeves and caulk at penetrations through building floor for watertight installation. In an elevated floor slab installation, bracket the piping to bottom of floor once the slab is poured.

F. Refer to Division 22 Section “Water Distribution Piping and Specialties” for trap primer and trap primer inlet pipe requirements.

3.11 INSTALLATION TRAP SEALS:

A. Install trap seals in accordance with manufacturer's written instructions and in locations indicated.

B. Make watertight seal using an adhesive type caulk along bottom of trap seal, if required by the manufacturer.

C. Employ a test plug for testing and remove before normal floor drain use. Clean inside of drain tailpiece and install trap seal after testing.

D. Do not touch elastomeric plug or allow contact with primer or solvent cement.

3.12 FLUSH GUARDS:

A. Coordinate installation per manufacturer's instructions.

3.13 CONNECTIONS

A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.

B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.14 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

    a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.
    c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.
    d. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from

one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1” water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.

5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.15 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.16 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 221300

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SECTION 221328 - CONDENSATE PUMPS FOR HVAC EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of plumbing pumps:

1. Condensate pumps for HVAC equipment

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section “Coordination” for basic requirements for electrical components that are an integral part of packaged system components.
2. Division 22 Section “Sanitary Drainage and Vent Piping and Specialties” for condensate pipe material and installation requirements.
3. Division 26 Section “Common Work Results for Electrical” required electrical devices.
4. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including standard performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
2. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.
3. Maintenance data for condensate pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

1.3 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install condensate pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Plenum rated condensate pumps shall be listed and labeled by UL and comply with Standard 2043 “Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air Handling Spaces”.

D. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.

E. Single-Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.

F. Design Criteria: The Drawings indicate capacity, connections, and power requirements of condensate pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended

performance as judged by the Architect. The burden of proof for equality of plumbing pumps is on the proposer.

1.4 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Plenum Rated HVAC Condensate Pump:

a. Little Giant with no substitutions

2.2 PUMPS, GENERAL

A. Condensate Pumps: Factory assembled and factory tested.

B. Preparation for shipping: Provide suitable packaging to protect pump from damage during shipping.

2.3 CONDENSATE PUMPS FOR HVAC EQUIPMENT

A. General Description: Pumps shall be direct connected, single stage type with body and reservoir of a material suitable for plenum or non-plenum installation as scheduled on plans, normally open safety overflow switch with two dry contacts, integral check valve and power cord with ground.

B. Non-plenum rated: Reservoir and body shall be either ABS or PE plastic.

C. Plenum rated: Reservoir and body shall be all polypropylene and meet UL 2043.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s installation instructions.

B. Install pumps in locations and arrange to provide access for periodic maintenance.

C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

3.2 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine rough-in for plumbing piping systems to verify actual locations of piping connections prior to installation.

3.3 CONNECTIONS

A. Piping between the HVAC unit and the pump shall be the greater of the discharge port size on the HVAC equipment or 3/4” pipe size or as shown on plans, whichever is larger. Discharge piping from the condensate pump shall be equal to or greater than the diameter of the pump nozzle, minimum 3/4”, or as shown plans, whichever is larger. Condensate pump discharge pipe material is specified in Division 22 Section “Sanitary Drainage and Vent Piping and Specialties”.

B. Electrical wiring and connections are specified in Division 26 section “Common Work Results for Electrical”.

C. Coordinate interlock of condensate pump safety overflow switch with unit served to disable unit if safety overflow switch closes as noted on plans and schedules. HVAC interlock wiring and alarm interlock with the building automation system are specified in Division 23 Section “Direct-Digital Control for HVAC”.

3.4 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Ensure pump is connected to the condensate discharge system.
2. Verify all power wiring is in place and power is provided to pump.

B. Testing procedure for condensate pumps:

1. Pour water into the pump reservoir until the water sensing switch is activated.
2. Verify water is pumped out of the reservoir and that there are no leaks in the condensate piping or at the connection point to the pump.
3. Verify integral check valve is operating properly, replace with new if found to be defective.

END OF SECTION 221328

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SECTION 221400 - STORM DRAINAGE PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes building storm drainage piping systems, including drains and drainage specialties.

B. Contractors Option:

1. The Division 22 contractor may provide stainless steel storm drainage distribution piping systems in lieu of, in whole or in part, for cast iron storm pipe systems 8” and larger. Stainless steel storm drainage piping systems are specified in Division 22 Section 221402 “Stainless Steel Strom Drainage Piping and Specialties”.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
2. Division 33 Section "Storm Systems," for storm drainage piping beginning from 5'-0" outside the building.
3. Division 33 Section "Foundation Drainage," for foundation drainage piping.
4. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
5. Division 22 Section "Identification for Plumbing Piping and Equipment," for labeling and identification of drainage piping.
6. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
7. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
8. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage piping.
9. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

1.2 DEFINITIONS

A. Storm Building Drain: That part of the lowest piping of a drainage system which receives the discharge from storm drainage pipes inside the walls of the building and conveys it to the building sewer.

B. Storm Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer or private sewer or other point of disposal.

C. Drainage System: Includes all the piping within a public or private premises which conveys storm water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

B. Product data for the following products:

1. Drainage piping
2. Drainage piping specialties
3. Area drains
4. Trench drains
5. Roof drains
6. Hubless fitting restraints
7. Interceptors

C. Test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following codes:

1. 20__ BOCA National Building Code
2. 20__ International Plumbing Code
3. 20__ Standard Plumbing Code
4. 20__ Uniform Plumbing Code

B. Comply with the installation requirements for PVC gasketed sewer pipe per the Uni-Bell PVC Pipe Association “Installation Guide for Solid Wall PVC Sewer Pipe”. Comply with the installation requirements for gasketed fittings per the Uni-Bell PVC Pipe Association “Installation Guide for PVC Fittings and Laterals for Solid Wall PVC Sewer Pipe”.

C. Obtain installation training from the PVC gasketed sewer pipe manufacturer for all workers that will be installing or handling the PVC gasketed sewer pipe piping systems. Submit certification letter along with each workers certificate of completion to engineer of record within 30-days of mobilization. Include copy of certification letter with closeout documents.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Drainage Piping Specialties, including backwater valves, expansion joints, cleanouts, area/roof drains, cast-iron trench drains and downspout nozzles:

a. Josam Mfg. Co.
b. Sioux Chief Manufacturing Co. Inc.
c. Smith (Jay R) Mfg. Co.
d. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
e. Watts Industries, Inc.
f. Zurn Industries, Inc.; Hydromechanics Div.
g. Mifab Manufacturing, Inc.

2. Heavy Duty Hubless Couplings

a. Anaco Husky HD-2000
b. Clamp-All 80in. lb.
c. Ideal Tridon “HD”

d. Mission Rubber Company “Heavyweight”
e. ProFlo “HD”

3. Downspout Boots

a. Construction Castings Company
b. Flockart
c. Higgins Foundry
d. Neenah Foundry Company

4. Cast Iron Soil Pipe and Fittings

a. AB & I Foundry
b. Charlotte Pipe and Foundry Company
c. Tyler Pipe / Soil Pipe Division

5. Shielded Transition Couplings

a. FERNCO, “Proflex 3000 Series”
b. Mission Rubber Company, “Band Seal Specialty Couplings”

6. Underground Shielded Adapter Couplings

a. FERNCO, “1056 Series with SR73 Shear Ring”
b. Mission Rubber Company, “MR56 Series”

7. PVC DWV Fittings 16” and Larger

a. Plastic Trends, Inc.

8. Hubless Fitting Restraints

a. Holdrite

9. Hydromechanical Sand/Oil Interceptors:

a. Josam Mfg. Co.
b. Mifab Manufacturing, Inc.
c. Rockford Sanitary Systems
d. Smith (Jay R) Mfg. Co.
e. Watts Industries, Inc.
f. Zurn Industries, Inc.; Hydromechanics Div.

10. Plastic Hydromechanical Sand/Oil Separators:

a. CANPLAS
b. Green Turtle, Inc.
c. Mifab Manufacturing, Inc.
d. Striem

11. Plastic Gravity Sand/Oil Separators

a. Green Turtle, Inc.
b. Mifab Manufacturing, Inc.
c. Striem

d. Xerxes Corp.

12. PVC DWV Expansion Joints

a. Charlotte Pipe and Foundry Company #133
b. Spears Manufacturing Company #S119

13. Heavy Duty Hubless Couplings for Below Slab

a. Anaco Husky HD-4000
b. Clamp-All 125in. lb.

2.2 ABOVE GROUND DRAINAGE PIPE AND FITTINGS

A. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, hubless pipe and fittings, and bearing the trademark of CISPI and NSF.

1. Heavy duty couplings and compression gaskets: ASTM C564, ASTM C1540 and meeting FM 1680.

B. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast-bronze, drainage pattern fittings with soldered joints.

1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

C. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with “solid wall” PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints. Fittings 16” and larger shall be fabricated type.
2. Solvent: ASTM D2564.

D. Steel Pipe: ASTM A53, Type E or S, schedule 40, Grade B, galvanized, threaded ends.

1. Galvanized Malleable Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ASME B1.20.1.

E. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.3 UNDERGROUND BUILDING DRAIN PIPE AND FITTINGS

A. Cast-Iron Soil Pipe: ASTM A74, Service weight, hub-and-spigot soil pipe and fittings, and bearing the trademark of CISPI and NSF. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces.

1. Neoprene Compression Gaskets: ASTM C564.

B. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with “solid wall” PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
2. Solvent: ASTM D2564.

C. PVC Gasketed Sewer Pipe: SDR 26 pipe meeting ASTM F679 with “solid wall” PVC meeting ASTM D1784 and with integral bell type gasketed joints meeting ASTM D3212 with beveled male pipe ends and insertion depth markers.

1. Gasketed Fittings: Drainage pattern type meeting ASTM D3034 with integral bell type gasketed joints meeting ASTM D3212 with beveled male pipe ends.

D. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

2.4 DRAINAGE PIPING SPECIALTIES

A. Backwater Valves: Valve assembly shall be bronze fitted cast-iron, with bolted cover. Flapper shall provide a maximum 1/4 inch clearance between flapper and seat for air circulation. Valve ends shall suit piping material.

B. Expansion Joints: Cast-iron body with adjustable bronze sleeve, bronze bolts with wing nuts.

C. Cleanout Plugs: As specified on the drawings.

D. Floor Cleanouts: As specified on the drawings.

E. Wall Cleanouts: As specified on the drawings.

F. Area drains: As specified on the drawings.

G. Roof Drains: As specified on the drawings.

H. PVC DWV Expansion Joints: Schedule 40 PVC DWV meeting ASTM D2665 with socket connections and telescoping expansion joint with EPDM O-ring seal.

2.5 HUBLESS FITTING RESTRAINTS

A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install pipe and specialties in accordance with manufacturer’s installation instructions.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS

A. Pipe Beds:

1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section “General Plumbing Requirements” for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 “Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications” for additional requirements.

2. Cast Iron Soil Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation and maintain continuous pipe slope. For piping with rock trench bottoms, provide sand pipe bed 6” underneath and around sides of pipe, including fittings. After pressure testing is complete, install subbase. Refer to Section “General Plumbing Requirements” for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.3 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

A. Install hubless, cast-iron soil pipe and fittings 15” and smaller for storm pipe.

B. Install Type DWV copper tube with cast bronze Type DWV fittings 15” and smaller for storm pipe where indicated on the drawings.

C. As a contractor’s option with Owner approval, install PVC Type DWV Plastic pipe and fittings for 24 inch and smaller storm pipe. Install fabricated fittings for 16 inch and larger.

3.4 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

A. Install hub-and-spigot, service weight, cast-iron, soil pipe and fittings with gasketed joints for 15 inch and smaller storm pipe.

B. As a contractor’s option with Owner approval, install PVC Type DWV Plastic pipe and fittings for 24 inch and smaller storm pipe. Install fabricated fittings for 16 inch and larger.

C. Install PVC gasketed sewer pipe and gasketed fittings for 27” and larger storm pipe.

3.5 PIPE AND TUBE JOINT CONSTRUCTION

A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."

B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:

1. Install heavy duty hubless couplings on storm drainage piping, including connections to roof drains.
2. Install Hubless fitting restraints on joints 5” and larger at:

a. Changes of direction from vertical to horizontal
b. 4” branch connections, including tees, wyes and wye combination fittings to storm drainage piping 5” and larger
c. Horizontal changes of direction 22-1/2 degrees and greater

C. Install heavy duty hubless couplings on hubless storm piping ping below floor.

D. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.

E. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.

F. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.

G. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

H. Gasketed Fittings: Install fittings per the Uni-Bell PVC Pipe Association “Installation Guide for PVC Fittings and Laterals for Solid Wall PVC Sewer Pipe”.

3.6 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section "Basic Piping Materials and Methods” for special sealers and materials.

H. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls using sleeves and mechanical sleeve sealers. Refer to Division 22 Section “Basic Piping Material and Methods” for additional information.

I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing” for special sealers and materials.

J. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing” for special sealers and materials.

K. Foundation Penetrations: Where pipes pass through foundation walls above strip footings or under strip footings, protect pipes from building load with cast iron soil pipe sleeves two pipe sizes larger than the pipe. Sleeves installed under the strip footing shall be encased in concrete.

L. Make changes in direction for drainage piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends

where two fixtures are installed back to back and have a common drain. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

M. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

N. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger.

O. Extend building drain to connect to service piping, of size and in location indicated for service entrance to building. Storm service piping is specified in a separate section of Division 2.

P. Install 1 inch thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend minimum of 12" beyond each side of pipe. Install directly over, and center on pipe center line.

3.7 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections “Hangers and Supports for Plumbing Piping” and “Plumbing Insulation”.

    a. Install high density insulation on insulated pipe.

4. Provide vinyl coated hangers and riser clamps for use with PVC pipe.
5. Provide roll hangers for individual horizontal runs 100 feet or longer.

C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size	Steel Pipe Max. Span	Copper Tube Max. Span.	Min. Rod Dia. - Inches
In Inches	In Feet	In Feet	
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 3	12	10	3/8
4	12	10	3/8
5	12	10	1/2

6	12	10	1/2
8	12	10	1/2
10 to 12	12	10	5/8
14	12	N/A	3/4
16	12	N/A	7/8

1. Support all sizes of hubless horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide sway brace on horizontal piping at not more than 40' intervals to prevent horizontal movement. Provide support at each horizontal branch.
2. Support all sizes of vertical cast iron piping every ten feet.
3. Support all sizes of vertical steel piping every other floor, not to exceed twenty-five feet.
4. Support all sizes of horizontal of PVC piping every four feet.
5. Support all sizes of vertical of PVC piping every floor, but not to exceed ten feet. For sizes 2 inches and smaller, provide guide midway between required vertical supports.
6. Support vertical PVC pipe and tube every six feet, at base of each floor, and provide mid-story guides.
7. Support piping within 12" of each elbow or tee.
8. Support all sizes of underslab hubless horizontal cast iron piping every three feet and every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide support at each horizontal branch. For piping 2'-0" or more deep from bottom of slab, provide Styrofoam block minimum 4" from bottom and sides of pipe up to bottom of slab to prevent heaving of pipe. Cut interior of Styrofoam to fit hangers and fittings. Wrap Styrofoam all around with 7 mil thick plastic sheathing by Visqueen.
9. Sway bracing:
10. Provide rigid sway bracing for pipe 4" and larger at changes of direction greater than 45 degrees.

D. Bracing:

1. Provide horizontal bracing for pipe 4" and larger at intervals not to exceed 40'.

E. Bracing for above floor base of stacks 4" and larger and higher than three stories:

1. Secure horizontal base of stack to structure with riser clamp within at the fitting changing direction of flow from vertical to horizontal. Provide rods of size equal to cast iron pipe size scheduled above in pipe hanger schedule.

3.8 INSTALLATION OF PIPING SPECIALTIES

A. Provide PVC DWV expansion joints every 30' on straight vertical PVC waste or sanitary stacks receiving hot water waste. Install expansion joint at middle travel for equal expansion and contraction travel. Provide riser clamps within 18" of each end of expansion joint. Install expansion joint per manufacturer's installation instructions.

B. Install expansion joints on stacks or horizontal piping as indicated, and as required by the plumbing code.

C. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;

3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
4. at base of each vertical soil, waste, or storm water stack.

D. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.

E. Floor Cleanouts: Install in below floor building drain piping as indicated and:.

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;
3. Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping;
4. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

F. Exterior Cleanouts: Install exterior cleanouts embedded in a 18" x 18" x 8" block of concrete, flush with finished grade.

3.9 INSTALLATION OF AREA DRAINS

A. Install area drains in locations indicated.

B. Install area drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

C. Refer to architectural documents for floor slope requirements and set area drain elevation to match. Where architectural documents do not indicate the requirements, set the area drain elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

DEPRESSION IN INCHES	RADIUS OF AREA DRAINED - FEET
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

D. Provide P-traps for drains connected to combined sanitary and storm sewer.

E. Install area drains in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

F. Position drains so that they are level, accessible and easy to maintain.

3.10 INSTALLATION OF ROOF DRAINS

A. Install roof drains at low points of roof areas with the roof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and roof membrane.

B. Install drain flashing collar or flange so that no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.

C. Position roof drains so that they are accessible and easy to maintain.

3.11 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation the storm drainage piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

    a. Rough-in Inspection: Arrange for inspection of the storm drainage piping system before concealed or closed-in after system is roughed-in.
    b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
    c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.
    d. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test: Test storm drainage system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new storm drainage piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of storm drainage piping systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.12 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Clean drain strainers and domes. Remove dirt and debris.

3.13 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

C. Exposed PVC Piping: Protect storm drainage piping exposed to sunlight with 2 coats of a water based latex paint.

END OF SECTION 221400

SECTION 223701 - HYBRID HEAT PUMP DOMESTIC WATER HEATERS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. Hybrid heat pump domestic water heaters.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
2. Division 22 Section “Common Work Results for Plumbing” for concrete equipment pads.
3. Division 22 Section "Basic Piping Materials and Methods" for pipe joining materials, unions, dielectric unions, dielectric flanges, dielectric flange kits and basic installation requirements.
4. Division 26 Section “Common Work Results for Electrical” required electrical devices.
5. Division 26 Section "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

1. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories, and indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.
2. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.
3. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."

1.3 QUALITY ASSURANCE

A. Comply with UL 1995 “Safety for Heating and Cooling Equipment.”

B. UL 1453, "Electric Booster and Commercial Storage Tank Water Heaters."

C. Comply with NFPA 70 "National Electrical Code."

D. Provide water heaters that are listed and labeled.

1. The terms "listed" and "labeled" shall be 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.

E. ASME Code Compliance: Provide safety relief valves that comply with ASME Boiler and Pressure Vessel Code and that bear the appropriate code symbols.

F. State Boiler Code Compliance: Provide safety relief valve and accessories that comply with the state boiler code in effect.

G. Design Concept: The drawings indicate types and capacities of water heaters and are based on specific descriptions and manufacturers indicated. Water heaters having equal performance characteristics by other manufacturers may be considered provided that deviations in capacities, dimensions, operation, or other characteristics are minor and do not change the design concept or intended performance as judged by the Engineer. Burden of proof for equality of water heaters is on the proposer.

1.4 WARRANTY

A. Special Project Warranty: Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, controls, tanks, and coils. This warranty shall be in addition to, and not a limitation of, other rights the Owner may have against the Contractor under the Contract Documents.

1. Below is an example only; revise warranty period as required after verifying availability from warrantor. Select warranty for water heater below with those specified in section 2.Hybrid Heat Pump Water Heaters

a. Tank: Three Year.
b. Controls, Compressor and Parts: One Year.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Hybrid Heat Pump Domestic Water Heaters:

a. Lochinvar Water Heater Corp.
b. Rheem Mfg.
c. Ruud Mfg. Div.; Rheem Mfg.
d. A.O. Smith Water Products Co. Div.; A.O. Smith Corp.
e. State, Industries, Inc.

2. Thermal Expansion Tanks:

a. Armstrong Pumps, Inc.
b. Amtrol, Inc.
c. Bell & Gosset, ITT.
d. TACO, Inc.
e. Watts.
f. Wessels Tank Co.

2.2 HYBRID HEAT PUMP DOMESTIC WATER HEATERS

A. Description: Automatic, commercial, electric and heat pump; with vertical, 150-psig-rated storage tank, integral controls, drain valve, and relief valve.

B. Insulation: Non-CFC foam, surrounding tank.

C. Jacket: Steel, with baked-on enamel finish.

D. Tank: Glass-lined steel with anode rods and drain valve.

E. Heating Elements: Dual screw-in immersion type.

F. Heat Pump: Integral packaged compressor, evaporator fans and associated refrigeration components factory charged with R134A refrigerant.

G. Controls: Electronic temperature adjustment the LCD display control with [immersion thermostats] [surface mounted thermostats]. Operating mode selection between efficiency, hybrid and electric.

H. Safety Controls: Automatic, high-temperature-limit cutoff.

I. Temperature and Pressure Relief Valve: ASME rated and labeled.

J. Vacuum Relief Valve: ANSI Z21.22.

2.3 THERMAL EXPANSION TANKS

A. Thermal Expansion Tanks: Provide size and number as indicated; construct of welded carbon steel listed for 150 psig working pressure, 200 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a FDA approved butyl rubber diaphragm securely sealed into tank. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s installation instructions.

3.2 CONCRETE EQUIPMENT BASES

A. Construct concrete equipment bases in accordance with Division 22 Section “Common Work Results for Plumbing” for concrete and setting of equipment.

3.3 WATER HEATER INSTALLATION

A. General: Install water heaters on concrete equipment bases. Set and connect units in accordance with manufacturer's written installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Orient so controls and devices needing service are accessible.

B. Install thermometers on water heater outlet piping. Thermometers are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."

3.4 EXPANSION TANK INSTALLATION

A. Support expansion tank from structure. Do not hang expansion tank from piping.

B. Charge expansion tank bladder with air to a pressure equal to the domestic water static pressure.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to equipment arranged to allow servicing and maintenance.
2. Connect hot and cold water piping to units with shutoff valves and unions. Connect hot water circulating piping to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain.

    a. Where water heater piping connections are dissimilar metals, install dielectric waterway fittings or dielectric unions for joints 2” and smaller and install dielectric flanges for joints 2-1/2” and larger. Dielectric waterway fittings, unions and flanges are specified in Division 22 Section "Basic Piping Materials and Methods."
    b. Install vacuum relief valve in cold water inlet piping.

3. Provide water heater tank drain with shutoff valve indirect drain and discharge to floor drain with air gap. Indirect drains, specified as condensate drains, and their installation requirements are specified in Division 22 Specification Section “Sanitary Drainage and Vent Piping and Specialties.”
4. Provide condensate drain from condensate water heater drain connection furnished with water heater. Provide P-trap with minimum 1 inch trap seal and discharge to nearest floor drain with air gap. Condensate drains and their installation requirements are specified in Division 22 Specification Section “Sanitary Drainage and Vent Piping and Specialties.”
5. Install heat traps at inlet and outlet of each hybrid heat pump domestic water heater storage tank. Heat trap shall be made of elbows and piping. Heat trap shall turn down to 12” below the outlet or inlet, run 12” horizontal and turn up to the cold water to the heater or hot water from the heater. Where multiple tanks are connected with a manifold, a single heat trap may be provided at the connection of the cold water supply to the cold water manifold together.

B. Electrical Connections:

1. Power wiring is specified in Division 26 Section “Common Work Results for Electrical”
2. Field-installed disconnects are specified in Division 26 Sections "Enclosed Switches and Circuit Breakers".
3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.6 FIELD QUALITY CONTROL

A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate operation of equipment as specified below.

1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

3.7 STARTUP

A. Perform the following before start-up final checks:

1. Fill water heaters with water.
2. Piping systems test complete.
3. Check for piping connections leaks.

4. Test operation of safety controls and devices.

B. Perform the following start-up procedures:

1. Energize circuits.
2. Adjust operating controls.
3. Select hybrid operating mode.
4. Adjust hot water outlet temperature setting.

3.8 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 223701

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 7 Section "Joint Sealers," for materials and methods for sealing between plumbing fixtures and interior walls.
2. Division 10 Section "Service Wall Systems" for wall modules with built-in plumbing fixtures.
3. Division 22 Section "General Duty Valves for Plumbing Piping" for valves used as supply stops.

C. Products furnished but not installed under this Section include:

1. Plumbing fittings (including faucets) and piping indicated, for fixtures, appliances, appurtenances, and equipment provided by Owner.
2. Plumbing fittings (including faucets) and piping indicated, for fixtures, appliances, appurtenances, and equipment specified in other Sections.

D. Products installed but not furnished under this Section include:

1. Owner-supplied fixtures, as indicated.
2. Accessories, appliances, appurtenances, and equipment specified in other Sections, requiring plumbing services or fixture-related devices, as indicated.

1.2 DEFINITIONS

A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.

B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.

C. Appliance: Device or machine designed and intended to perform a specific function.

D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.

E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.

F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.

G. Fixture: Installed receptor connected to the water distribution system, that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.

H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.

I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:

1. Carrier: Floor-mounted support for wall-mounted water closet, and support fixed to wall construction for wall-hung fixture.
2. Chair Carrier: Support for wall-hung fixture, having steel pipe uprights that transfer weight to the floor.
3. Chair Carrier, Heavy Duty: Support for wall-hung fixture, having rectangular steel uprights that transfer weight to the floor.
4. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.

J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

K. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.
2. Wiring diagrams for field-installed wiring of electrically operated units.
3. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

B. Submit third party certification that faucets and trim for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following faucets and trim need not comply:

1. Electronic faucets
2. Service sink faucets
3. Flush valves

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of ANSI Standard A117.1, "Buildings and Facilities -- Providing Accessibility and Usability for Physically Handicapped People," Public Law 90-480, "Architectural Barriers Act, 1968," with respect to plumbing fixtures for the physically handicapped and "Americans with Disabilities Act Accessibility Guidelines for Buildings 1991" with respect to plumbing fixtures for the physically handicapped.

Commented [JP1]: Removed ATBCB requirements.

B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.

C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of faucets and trim containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

D. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixtures is on the proposer.

1.5 WARRANTY

A. Provide warranty as required by spec section 220010.

1.6 SPARE PARTS

Commented [JP2]: Added Spare parts section back in without non-applicable items, non-proprietary items and readily available items that affect non-critical fixtures. The client is good at getting things.

A. Deliver spare parts to Owner. Furnish spare parts described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.

B. Faucet Washers and O-rings: Furnish quantity of identical units not less than 10 percent of amount of each installed.

C. Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5 percent of amount of each installed.

D. Flushometer Repair Kits: Furnish quantity of identical units not less than 10 percent of amount of each flushometer installed.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed for that category:

1. Water Closets:

a. American Standard, Inc.
b. Barclay Products Ltd.
c. Briggs Div.; Briggs Industries, Inc.
d. Gerber Plumbing Fixture Corp.
e. Kohler Co.
f. Mansfield Plumbing Products, Inc.
g. Microphor, Inc.
h. PROFLO
i. Sloan Valve Co.
j. TOTO KIKI USA, Inc.
k. Water Control International, Inc.
l. Zurn Plumbing Products Group

2. Urinals:

    a. American Standard, Inc.
    b. Briggs Div.; Briggs Industries, Inc.
    c. Gerber Plumbing Fixture Corp.
    d. Kohler Co.
    e. Mansfield Plumbing Products, Inc.
    f. PROFLO
    g. Sloan Valve Co.
    h. TOTO KIKI USA, Inc.
    i. Zurn Plumbing Products Group

3. Lavatories:

    a. Acorn Engineering Co.
    b. American Standard, Inc.
    c. Barclay Products Ltd.
    d. Briggs Div.; Briggs Industries, Inc.
    e. Gerber Plumbing Fixture Corp.
    f. International Sanitary Ware Manufacturing Co.
    g. Just Manufacturing Co.
    h. Kohler Co.
    i. Mansfield Plumbing Products, Inc.
    j. PROFLO
    k. Sloan Valve Co.
    l. TOTO KIKI USA, Inc.
    m. Zurn Plumbing Products Group

4. Sinks:

    a. American Standard, Inc.
    b. Briggs Div.; Briggs Industries, Inc.
    c. Elkay Manufacturing Co.
    d. Franke
    e. Just Manufacturing Co.
    f. Kohler Co.
    g. Moen Group; Stanadyne Corp.
    h. PROFLO

5. Ablution Fixtures:

    a. WuduMate

6. Mop Basins:

    a. Acorn Engineering Co.
    b. Fiat Products.
    c. Florestone Products Co., Inc.
    d. Stern-Williams Co., Inc.

7. Water Coolers:

    a. Acorn / Aqua
    b. Elkay Manufacturing Co.

Commented [JP3]: Added manufacturer's back in to mitigate supply chain issues.

Commented [JP4]: Removed waterless urinals.

Commented [JP5]: Added manufacturer's back in to mitigate supply chain issues.

Commented [JP6]: Removed Service Sink.

Commented [JP7]: Removed bathtubs, showers, whirlpools, and drinking fountains from spec.

c. Filtrine Manufacturing Co.
d. Halsey Taylor; A Household International Co.
e. Haws Drinking Faucet Co.

8. Outlet Boxes:

a. Guy Gray Manufacturing Co., Inc.
b. Symmons Industries, Inc.
c. Oatey Co.

9. Toilet Seats:

a. Bemis Mfg. Co.
b. Beneke Div.; Sanderson Plumbing Products, Inc.
c. Church Seat Co.
d. Kohler Co.
e. Olsonite Corp.
f. Sperzel Industries, Inc

10. Flushometers – Diaphragm Type:

a. Coyne & Delany Co.
b. Sloan Valve Co.
c. Zurn Industries, Inc.; Flush Valve Operations.

11. Flushometers – Piston Type:

a. American Standard, Inc
b. Kohler Co.
c. Sloan Valve Co.
d. Toto Kikki, USA
e. Zurn Industries, Inc.; Flush Valve Operations.

12. Commercial/Residential Cast-Brass and Cast-Brass Underbody Faucets:

a. American Standard, Inc.
b. Brass Craft Subsidiary; Masco Corp.
c. Briggs Div.; Briggs Industries, Inc.
d. Central Brass Manufacturing Co.
e. Delta Faucet Co.; Div. of Masco Corp.
f. Elkay Manufacturing Co.
g. Gerber Plumbing Fixtures Corp.
h. Grohe America, Inc.
i. Kohler Co.
j. Moen Group; Stanadyne Corp.
k. Price Pfister, Inc.
l. Royal Brass Mfg. Co.
m. Symmons Industries, Inc.
n. Valley Faucets Div.; U.S. Brass.

13. Sensor-Operated Faucets and Devices:

a. Sloan Valve Co.
b. Zurn Industries, LTD. “Aqua Spec”

Commented [JP8]: Added manufacturer’s back in to mitigate supply chain issues.

Commented [JP9]: Removed Bidets.

Commented [JP10]: Removed Emergency Equipment.

Commented [JP11]: Added toilet seats and outlet boxes back in.

Commented [JP12]: Added manufacturer’s back in to mitigate supply chain issues.

Commented [JP13]: Added brass faucets back in for sinks, mop sinks, etc.

Commented [JP14]: Removed Commercial industrial faucets, Residential/light commercial faucets, residential pressure balance faucets, commercial pressure balance faucets, TMV faucets, and shower floors.

Commented [JP15]: Maintaining edited list

14. Stop Valves & Supplies:

    a. Brass Craft Subsidiary; Masco Co.
    b. Chicago Faucet Co.
    c. Engineered Brass Company
    d. Kohler Co.
    e. McGuire Manufacturing Co., Inc.
    f. PROFLO
    g. Royal Brass Mfg. Co.
    h. T & S Brass and Bronze Works, Inc.
    i. Watts Brass and Tubular
    j. Zurn Industries

15. P-traps, Drains & Miscellaneous Fittings:

    a. Brass Craft Subsidiary; Masco Co.
    b. Dearborn Brass
    c. Engineered Brass Company
    d. Franke
    e. McGuire Manufacturing Co., Inc.
    f. PROFLO
    g. Watts Brass and Tubular
    h. Zurn Industries

Commented [JP16]: Added manufacturer's back in to mitigate supply chain issues.

16. Supports:

    a. Josam Co.
    b. Smith (Jay R.) Mfg. Co.
    c. Wade Div.; Tyler Pipe.
    d. Watts Drainage Products
    e. Zurn Industries, Inc.; Hydromechanics Div.
    f. Mifab Manufacturing, Inc.

Commented [JP17]: Removed hot water dispenser and disposer.

17. Insulation Kits

    a. Brocar
    b. McGuire
    c. Plumberex
    d. PROFLO
    e. Trap-Wrap
    f. Truebro, Inc.

2.2 PLUMBING FIXTURES, GENERAL

Commented [JP18]: Refer to section 2.1 for specific sections removed below.

A. Provide plumbing fixtures and trim, fittings, other components, and supports as specified on the drawings and below:

2.3 ABLUTION FIXTURES

A. Provide ablution fixtures as specified on drawings with tap furnished by manufacturer.

2.4 FAUCETS

A. Faucets General: As described on the drawings.

1. Maximum flow rate:

    a. Lavatories / Ablution: 0.35 GPM
    b. Kitchen / Breakroom Sinks: 1.20 GPM

2.5 STOP VALVES & SUPPLIES

A. Supplies General: As described on the drawings.

1. Exposed piping and parts shall be polished chrome plated.

2.6 P-TRAPS, DRAINS AND MISCELLLANEOUS FITTINGS:

A. Fittings General: As described on the drawings, except as listed below.

1. Exposed piping and fittings shall be polished chrome plated.
2. Fittings installed concealed inside a plumbing fixture or within wall construction may be without chrome plate finish.
3. Fitting and faucet bodies for domestic water distribution shall be of lead free brass or lead free cast bronze.

B. Sink Continuous Wastes: Polished chrome-plated, tubular brass, 1-1/2 inches, 17 gauge, with brass nuts on slip inlets, and of configurations indicated.

C. Escutcheons: Polished chrome-plated, sheet steel wall flange with friction clips.

Commented [JP19]: Removed bathtub p-traps and wall flange escutcheon.

D. Deep Pattern Escutcheons: Wall flange with set screw or sheet steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

2.7 FLUSHOMETERS

A. Provide flushometers compatible with fixtures, with features indicated as described on the drawings.

1. Exposed metal parts shall be polished chrome plated.
2. Flush valves installed within wall construction may be without chrome plate finish.
3. Maximum average flush rate:

    a. Water Closets: 1.280 GPF
    b. Urinals: 0.125 GPF

2.8 TOILET SEATS

A. General: As described on the drawings.

2.9 PLUMBING FIXTURE SUPPORTS

A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.

B. Support categories are:

1. Carriers: Supports for wall-hanging water closets and fixtures supported from wall construction. Water closet carriers shall have an additional faceplate and coupling when

used for wide pipe spaces. Provide tiling frame or setting gauge with carriers for wall-hanging water closets.
2. Chair Carriers: Supports with steel pipe uprights for wall-hanging fixtures. Urinal chair carriers shall have bearing plates.
3. Chair Carriers, Heavy Duty: Supports with rectangular steel uprights for wall-hanging fixtures.
4. Reinforcement: 2-inch by 4-inch wood blocking between studs or 1/4-inch by 6-inch steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.

C. Support Types: Provide support of category specified, of type having features required to match fixture.

D. Provide supports specified as part of fixture description, in lieu of category and type requirements above.

2.10 INSULATION KITS

A. Insulation kits for lavatory and sink waste and supplies of vinyl plastic with reusable fasteners and openings for access to supply stop handles.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fixtures, trim and supports in accordance with manufacturer’s installation instructions.

3.2 APPLICATION

A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.

B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:

1. Carriers for following fixtures:

a. Wall-hanging water closets.
b. Wall hanging lavatories
c. Wall hanging electric water coolers and drinking fountains.
d. Wall-hanging fixtures supported from wall construction.

2. Chair carriers for the following fixtures:

a. Wall-hanging urinals.
b. Wall-hanging lavatories and sinks.
c. Wall-hanging drinking fountains and electric water coolers.

3. Heavy-duty chair carriers for the following fixtures:

a. Accessible lavatories.
b. Fixtures where specified.

4. Reinforcement for the following fixtures:

a. Floor-mounted lavatories required to be secured to wall.
b. Floor-mounted sinks required to be secured to wall.
c. Recessed, box-mounted electric water coolers.
d. Wall mounted and mop sink faucets.
e. Urinal flush valve solid pipe ring supports.

3.3 INSTALLATION OF PLUMBING FIXTURES

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in drawings, and referenced standards.

B. Install floor-mounted, floor-outlet water closets with closet flanges and gasket seals.

C. Install floor-mounted, back-outlet water closets with fittings and gasket seals.

D. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gauge.

E. Install wall-hanging, back-outlet urinals with gasket seals.

F. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.

G. Fasten floor-mounted fixtures and special fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.

H. Fasten wall-mounted fittings to reinforcement built into walls.

I. Fasten counter-mounting-type plumbing fixtures to casework.

J. Secure supplies behind wall or within wall pipe space, providing rigid installation.

K. Set mop basins in leveling bed of cement grout.

L. Install stop valve in an accessible location in each water supply to each fixture.

Commented [JP20]: Edited out fixtures removed in 2.1.

M. Install trap on fixture outlet except for fixtures having integral trap.

N. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.

Commented [JP21]: Removed fixture seals.

O. Install insulation kits on ADA compliant sink and lavatory waste, continuous wastes, hot and cold water supplies where indicated on the drawings and as required by the ADA.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.
2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3. Install piping connections for ablution fixtures above grade from rear through access panel.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.

D. Replace washers of leaking and dripping faucets and stops.

E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.

F. Adjust faucet wrist blade handles perpendicular to the spout while in the closed position.

G. Review the data in Operating and Maintenance Manuals. Refer to Division 1 Section "Project Closeout."

Commented [JP22]: Remove shower set point.

3.7 FIXTURE SCHEDULE

A. Provide plumbing fixtures as specified on the drawings.

B. Install rough-in for plumbing fixtures as scheduled on the drawings.

3.8 MOUNTING HEIGHTS SCHEDULE:

Commented [JP23]: Edited for project fixtures

A. Refer to the architectural drawings for plumbing fixture mounting heights. Unless indicated otherwise, install plumbing fixtures with the mounting heights as listed below with final approval by the Architect:

FIXTURE	MOUNTING HEIGHT
Lavatory or Sink	
Standard Height	31" floor to rim
ADA Accessible	34" floor to rim
Urinal	
Standard Height	24" floor to rim
ADA Accessible	17" floor to rim
Water Closet	
Standard	15" floor to rim
ADA Accessible	17” to 19" floor to top of seat
Water Cooler or Drinking Fountain	

Standard Height	41" floor to spout
ADA Accessible	36" floor to spout
Janitor's Sink Faucet Fittings	42" floor to centerline
Hose Bibbs	36" AFF to centerline
Non Freeze Wall Hydrant	18" AFG to centerline

END OF SECTION 224000

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SECTION 230010 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

BOCA	Building Officials Code Administration
UBC	Uniform Building Code
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
IBC	International Building Code
IMC	International Mechanical Code
IPC	International Plumbing Code
IECC	International Energy Conservation Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
ADA	American Disabilities Act
ADC	Air Diffusion Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer’s Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: The term “furnish” is used to mean “supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations.”
2. Install: The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”
3. Provide: The term “provide” means “to furnish and install, complete and ready for the intended use.”
4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.
6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. CMATT: Certified Acceptance Mechanical Test Technician. A professional certified to perform acceptance tests and complete the documentation required for nonresidential acceptance tests as required by the Building Energy Efficiency Standards. Technician shall be certified by an authorized mechanical acceptance test technician certification provider.
8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
    b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

10. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Bedding: Bedding as used in this section refers to the compacted sand or pea gravel installed in the bottom of a trench to immediately support and cover a pipe or duct.
3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.
6. Building Fill: Building fill as used in this section refers to borrowed fill material of rock 1” and larger used to fill foundation excavations

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine

exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. Provide the number of submittals required by Division 01; General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

F. Refer to individual Sections for additional submittal requirements.

G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

I. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

J. Refer to Division 01 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the

procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

K. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

1.8 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.9 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

    a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
    d. Same warranty will be furnished for proposed substitution as for specified Work.

e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Each manual shall contain data listed in each individual Section.

1.11 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification.

1.12 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.13 TRAINING

A. Provide general training and equipment demonstration to Owners representative. This shall include, but is not limited major component location and basic equipment operation. The Owners representative should be aware of the basic building systems and their operation.

1.14 PAINTING

A. Exposed ductwork and ferrous surfaces, including pipe, pipe hangers, equipment stands and supports [and exposed insulated piping] shall be painted by the Contractor using materials and methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.16 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Installation Warranty

1. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
2. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
3. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

C. Equipment Warranty

1. Equipment vendor warrants equipment to be free from defect in material and workmanship for the length of the manufacturers standard warranty.
2. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.
2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, non-clogged condition during construction period.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees Fahrenheit. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.18 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the Site prior to submitting his bid to determine the nature and extent of work involved.
2. Work in the existing building shall be scheduled with the Owner.
3. Certain demolition work must be performed prior to the remodeling. The Mechanical Contractor shall perform the demolition which involves Mechanical systems, equipment, piping, equipment supports or foundations and materials.
4. Mechanical Contractor shall remove articles which are not required for the new Work. Unless otherwise indicated, each item removed by the Mechanical Contractor during this demolition shall become his property and shall be removed by the Mechanical Contractor

from the premises and dispose of them in accordance with applicable federal, state and local regulations.

5. Mechanical Contractor shall relocate and reconnect Mechanical facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Mechanical equipment or materials are removed, the Mechanical Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
6. General Contractor shall install finish material.
7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
9. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

C. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

D. Use of explosives is not permitted.

E. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

1.19 PERFORMANCE SPECIFICATIONS FOR SUSTAINABILITY GOALS

A. Utilize 100% electric HVAC systems.

1. Heat Pumps
2. Variable Refrigerant Systems with low GWP refrigerants

B. New HVAC units shall include a cooling system that exceeds the 2021 IECC IEER efficiency requirements by at least 10%. If the locally adopted energy code is more stringent, the units must comply with the local code requirements. Should this requirement negatively impact cost, schedule, or quality, the Pre-Construction or Construction Manager may authorize the use of units that meet the minimum standards outlined in the local energy code.

C. The design engineer shall recommend units to be reused or replaced based on their professional expertise, regardless of age of the equipment. It is recommended to replace existing packaged HVAC air handling equipment that is 10 years or older but there may be exceptions. Coordinate unit replacement with pre-construction manager.

D. Economizer requirements shall meet the local energy code.

1. When RTU's serve areas with open refrigeration, the economizer requirement may be omitted when allowed by code.

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 ACCEPTANCE TESTING REQUIREMENTS

A. Perform acceptance test procedures in accordance with the specifications listed in the Reference Joint Appendices for the Building Energy Efficiency Standards. Reference the Non-Residential Certificate of Compliance (NRCC) forms on the drawings for the systems which shall be tested.

B. Submit Non-Residential Certificate of Acceptance (NRCA) forms for each system for which the CMATT is responsible.

3.3 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.4 SELECTIVE DEMOLITION

A. Refer to Division 02 and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment to Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, and insulation.

    a. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.
    b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 23.

F. Provide schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

1. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

3.5 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation and Trenching shall be in conformance with applicable Division and section of the General Specifications.

C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.

D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

E. Erect barricades around excavations and trenches for safety. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.

F. Slope sides of excavations and trenches to comply with Geotechnical Report, local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations and trenches regardless of time period excavations and trenches will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering of Excavation and Trenches: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.

1. Do not allow water to accumulate in excavation or trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations and trenches.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas.
3. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations and trenches. Do not store within drip-line of trees indicated to remain.
2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Tanks, Basins, and Mechanical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.
2. Excavate trenches to depth indicated or required to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of sand or pea gravel prior to installation of pipe. Provide a minimum of 6 inches of sand or pea gravel cushion between rock bearing surface and pipe.
5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment bedding on undisturbed soil.

M. Cold Weather Protection: Protect excavation and trench bottoms against freezing when atmospheric temperature is less than 35°F.

N. Bedding:

1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below.
2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.

O. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under pipes, use bedding materials in layers to 6 inches above top of the pipe.
2. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
3. Under building slabs, use subbase materials.
4. Under piping and equipment, use bedding and subbase materials over rock bearing surface and for correction of unauthorized excavation.
5. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete protection slab. After installation and testing of pipes, provide a 4-inch thick concrete protection top slab prior to backfilling and placement of roadway subbase. Contractor shall coordinate with local AHJ as to requirements for colored concrete in this application.
6. Other areas, use excavated or borrowed materials where applicable.
7. Backfill excavations as promptly as work permits, but not until completion of the following:

    a. Inspection, testing, approval, and locations of underground utilities have been recorded.
    b. Removal of concrete formwork.
    c. Removal of shoring and bracing, and backfilling of voids.
    d. Removal of trash and debris.

8. Where gravel fill (drainage fill) is used as building fill material in lieu of natural soils, provide filter fabric material to line the trench to support the bedding fill material and subgrade materials to ensure that backfill materials will not segregate within the trench nor create voids and sags within the pipe trench.
9. Ductwork under slab shall be backfilled with a minimum of 4” bedding material on all sides for protection from soils (per Code). Subbase materials shall be utilized above the bedding material to the subgrade level.

    a. If concrete encasement is required, a minimum of 4” thickness all sides shall be provided unless otherwise noted. Contractor shall provide hold down straps as per manufacturer’s recommendations.
    b. If a concrete ballast pad is required, size of ballast pad shall be as noted on the drawings or as per manufacturer’s recommendations.

P. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.
2. Removal of concrete formwork.
3. Removal of shoring and bracing, and backfilling of voids.
4. Removal of trash and debris.

Q. Subgrade Placement and Compaction: Place subgrade backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

R. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

S. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

T. Placement and Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Use of pneumatic backhoe as compaction method is disallowed as an acceptable process for compaction of excavations or trenches.
2. For vertical and/or diagonal pipe installations greater than ½" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.
3. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.
5. Compaction: control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
6. Percentage of maximum density requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

    a. Areas under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 95 percent maximum density for cohesive material listed, or 95 percent relative density for cohesionless material.
    b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 95 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    c. Other Areas: Compact top 6 inches of subgrade and each layer of subbase backfill or fill material to 90 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

U. Subsidence: Where subsidence occurs at mechanical installation excavations and trenches during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.6 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.7 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall always cooperate in maintaining reasonably clean premises.

B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.8 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.
2. Submit complete Record Drawings.
3. Perform special inspections as required in each individual Section.
4. Start-up testing of systems.
5. Removal of temporary facilities from the site.
6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 230010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

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SECTION 230015 - ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "COMMON WORK RESULTS FOR ELECTRICAL” for specification of motor connections.

C. Refer to Division 26, "ENCLOSED CONTROLLERS" for specification of motor starters.

D. Refer to Division 26, "ENCLOSED SWITCHES AND CIRCUIT BREAKERS" for specification of disconnect switches and enclosed circuit breakers.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV23m	DIV23m	DIV26	---
Factory furnished motor starters contactors and disconnects	DIV23m	DIV23m	DIV26	DIV23t
Overload heaters	DIV23m	DIV26	---	---
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV26	DIV26	DIV26	DIV23t
Variable speed drives	DIV23m	DIV23m	DIV26	DIV23t
Manual operating multi-speed switches	DIV23m	DIV26	DIV26	DIV23t
Control relays	DIV23t	DIV23t	DIV26	DIV23t
Thermostats/Humidistat (low voltage)	DIV23t	DIV23t	---	DIV23t
Thermostats (line voltage)	DIV23m	DIV23m	DIV26	---
Time switches (for mechanical equipment)	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers furnished with equipment	DIV23m	DIV23m	DIV26	DIV23t
Temperature control panels (housing controllers)	DIV23t	DIV23t	DIV26	DIV23t
Building controllers, advanced application controllers, and application specific controllers	DIV23t	DIV23t	DIV23t	DIV23t
Damper operators, PE & switches	DIV23t	DIV23t	DIV23t	DIV23t
Duct Smoke detectors	DIV28	DIV23m	DIV28	DIV28
Temporary heating connections	DIV23m	DIV23m	DIV26	DIV23m
Interlocks between air handling units and exhaust fans	---	---	---	DIV23m
Interlocks between HVAC fans and damper operators	---	---	DIV26	DIV23t

DIV23m = Mechanical Contractor
DIV23t = Temperature Controls Sub-Contractor
DIV26 = Electrical Contractor
DIV28 = Electronic Safety and Security

END OF SECTION 230015

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SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:

1. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.
2. Mechanical equipment nameplate data.
3. Concrete for bases and housekeeping pads.
4. Non-shrink grout for equipment installations.
5. Sleeves for mechanical penetrations.
6. Drip Pans with detection.
7. Miscellaneous metals for support of mechanical materials and equipment.
8. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.
9. Joint sealers for sealing around mechanical materials and equipment.
10. Plenum insulation for enclosure of combustible items located within fire-rated plenums.
11. Firestopping

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 07 Section “Penetration Firestopping” for material and methods for firestopping systems.
2. Division 23 Section "Basic Piping Materials and Methods," for materials and methods for mechanical sleeve seals.
3. Division 23 Section “Instrumentation and Control for HVAC” for integration with building automation system of leak detection system “Water Present” alarm.
4. Division 26 Section “Common Work Results for Electrical” required electrical devices.
5. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 23 Section General Mechanical Requirements.

1. Product data for the following products:

a. Access panels and doors.
b. Joint sealers.
c. Through and membrane-penetration firestopping systems.
d. Plenum insulation.

2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
3. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

4. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

A. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

B. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
2. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wideexposed perimeter flange and adjustable metal masonry anchors.
b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

3. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

4. Locking Devices: Flush, screwdriver-operated cam locks.

2.2 MECHANICAL EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS

A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted mechanical equipment. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.

B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.

C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the latest applicable recommendations of the ACI standard practice manual. Concrete shall be composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.

D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x W2.9 welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24” on center with a minimum of two bars each direction.

E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.

F. Concrete equipment bases and housekeeping pads shall have height as specified on the drawings or minimum height if not specified in accordance with the following table:

Equipment	Minimum Height
Furnaces, Exterior Equipment Less than or equal to 20 tons and Other Equipment Not Listed	4”
Air Handling Units w/TSP less than or equal to 3.5” (See Note 1)	4”

NOTES:

1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.

2.4 GROUT

A. Provide non-shrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.

B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.

C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.5 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.6 DRIP PANS

A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2” lapped and soldered joints. Drip pan shall have a depth of 2” and a width of 6” in addition to the diameter of the associated pipe. Provide 3/4” galvanized pipe with male NPT outlet at low point of drip pan. Connect ¾” type “L” copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.

B. Drip pan supports shall be ¼” X 2” galvanized bar stock welded to the drip pan without holes. Provide ¼” galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.

C. Flood Detector: Flood detector switch utilizing hydrophilic pad and stainless steel sensor array to detect moisture. Switch shall be provided with integral feet to prevent pad from contacting the pan. Provide with solid state electronics and double throw relay to allow switch to shut down unit and provide an auxiliary alarm output.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Diversitech or approved equivalent

2.7 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.8 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

1. Manufacturers:

    a. Dow Corning, Dowsil 790.
    b. Dow Corning, Dowsil 795.
    c. GE, Silglaze II SCS 2350.
    d. GE, Silpruf SCS 2000.
    e. Owens Corning, Energy Complete.
    f. Pecora, 864 NST.
    g. Tremco, Spectrem 1.
    h. Tremco, Spectrem 2.

D. High Humidity Sealer: One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

1. Manufacturers:

    a. Dow Corning, Dowsil 786.
    b. GE, Momentum SCS1700.
    c. Pecora, 898 Silicone NST.

E. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.

1. Manufacturers:

    a. BASF, MasterSeal NP 100.
    b. Pecora, DyanTrol I-XL.
    c. Tremco, Dymonic FC.

F. Acrylic Latex Joint Sealer: One-part, non-sag, mildew-resistant, paintable acrylic latex or siliconized acrylic latex, complying with ASTM C834, Type OP, Grade NF, recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Manufacturers:

    a. Pecora, AC-20
    b. Sherwin Williams 950A
    c. Tremco, Tremflex 834

2.9 PLENUM INSULATION

A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.

B. Material: FyreWrap 0.5 Plenum Insulation, ETS Schaefer Plenumshield Blanket, Thermal Ceramics PlenumWrap+, or equivalent utilizing light weight, high temperature blanket enhanced for biosolubility. The encapsulating material shall be aluminum foil with fiberglass reinforcing scrim covering.

C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.

D. Physical Properties: Plenum insulation shall be single 1” minimum layer with a density of 2 to 6 pounds per cubic foot.

2.10 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E814, or other NRTL acceptable to AHJ.

B. Manufacturers:

1. 3M Corp., Fire Barrier Sealant.
2. Hilti.
3. Owens Corning, Firestopping Insulation.
4. Pecora, AC-20 FTR.
5. RectorSeal.
6. Specified Technologies Inc., Firestop.
7. USG SHEETROCK Firecode Compound.
8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.

3.2 INSTALLATION OF ACCESS DOORS

A. Provide access doors for all concealed equipment and duct and piping accessories that require service where indicated or as required, except where above lay-in ceilings. Refer to Section “Identification for HVAC Piping and Equipment” for labeling of access doors.

B. Access doors shall be adequately sized for the devices served with a minimum size of 24 inches x 24 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

C. Access doors must be of the proper construction for type of construction where installed.

D. The exact location of all access doors shall be verified with the Architect prior to installation.

E. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

F. Adjust hardware and panels after installation for proper operation.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.5 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.6 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.7 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.

H. Cut sleeves to length for mounting flush with both surfaces of walls.

I. Extend sleeves installed in floors 2 inches above finished floor level.

J. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

K. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

L. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 23 Section “Basic Piping Materials and Methods”.

3.8 DRIP PANS

A. Provide drip pans in locations indicated on drawings.

B. Provide drip pans for piping or equipment installed over electrical panels in variance with the drawings. Obtain approval from the Architect prior to installation.

C. Provide drip pans for piping directly above a two hour rated ceiling of an elevator machine room.

D. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.

E. Provide drip pan supports every 4’-0”.

F. Mount leak detection controller on wall adjacent to exit of the room above which the drip pan is located unless otherwise indicated on drawings indicated on drawings.

G. Coordinate disconnect and power supply for leak detection system and 120V dedicated receptacle adjacent to controller with Division 26. Power wiring and receptacles are specified in Division 26 Section “Common Work Results for Electrical”. Disconnects are specified in Division 26 Section “Enclosed Switches and Circuit Breakers”

H. Place flood detector in the lowest location in the drip pan. Interlock detector with the HVAC equipment per manufacturer’s recommendations.

I. Wire flood detector to remote alarm, Diversitech Universal Alarm or equivalent. Coordinate location of the remote alarm with building owner prior to installation.

J. Coordinate interlock of “Water Present” alarm with building automation system. Refer to Division 23 Section “Instrumentation and Control for HVAC” for integration with building automation system and low voltage power wiring.

3.9 PLENUM INSULATION

A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated plenums where permitted by the local authority having jurisdiction

B. Overlap: Provide a minimum 1” perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.

C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer’s written installation instructions.

D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated plenums where the use of plenum insulation is not approved.

END OF SECTION 230500

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SECTION 230510 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. Joining materials.

B. Escutcheons.

C. Unions.

D. Dielectric unions.

E. Pipe roof curbs.

1.2 SUBMITTALS

A. Refer to Division 01 and Division 23 Section “General Mechanical Requirements” for administrative and procedural requirements for submittals.

B. Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.

C. Quality Assurance Submittals: Submit welders' certificates specified in Article “Quality Assurance” below.

D. Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system application in the project including manufacturer’s catalog information, pipe materials, sizes, fittings, Type, Grade, Schedule, applicable ASTM standard, and connection method(s).

E. Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

G. Manufacturer's Installation Instructions: Indicate hanging and support methods and joining procedures.

H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

I. Shop Drawings: Include detailed fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.

J. Coordination Drawings: Include piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.

3. Structural members.

K. As-built drawings for each piping system in electronic and PDF format.

L. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.3 QUALITY ASSURANCE

A. Comply with ASME B31.9 - Building Services Piping, most recent edition.

B. Soldering and Brazing procedures shall conform to ANSI B9.1 Safety Code for Mechanical Refrigeration.

C. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ASME, and ANSI standards.

D. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

C. Refer to the individual piping system specification sections in Division 23 for additional requirements.

PART 2 - PRODUCTS AND MATERIALS

2.1 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

C. Brazing Filler Metals: Comply with SFA-5.8, Section II, ASME BPVC for brazing filler metal materials appropriate for the materials being joined.

1. AWS A5.8, Classification BAg–5:

a. Silver (Ag) 44.0 – 46.0 percent.
b. Zinc (Z) 23.0 – 27.0 percent.
c. Copper (Cu) 29.0 – 31.0 percent.

2. AWS A5.8, Classification BCuP–5:

a. Phosphorus (P) 4.8 - 5.2 percent.
b. Silver (Ag) 14.5 - 15.5 percent.
c. Copper (Cu) remainder.

D. Soldering Filler Metals: ASTM B32, 95-5 Tin-Antimony and water flushable flux in accordance with ASTM B813.

2.3 ESCUTCHEONS

A. Manufacturers:

1. AWI Manufacturing.
2. Keeney Manufacturing Company.
3. Wal-Rich Corp.
4. Jones Stephens Corp.
5. Approved equal.

B. Chrome-plated, stamped-steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

2.4 UNIONS:

A. Manufacturers:

1. Anvil International.
2. Hart Industries.
3. Mueller Streamline Co.
4. Victaulic Company of America.
5. Watts Regulator Co.
6. Approved equal.

B. Hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

1. Malleable-iron: ASME B16.39, class as specified in section “Hydronic Piping” for the piping system used.
2. Bronze: ASME B16.15, cast bronze body meeting ASTM B62, class as specified in section “Hydronic Piping” for the piping system used.

2.5 DIELECTRIC UNIONS

A. Manufacturers:

1. Hart Industries.
2. Victaulic Company of America.
3. Watts Regulator Co.
4. Approved equal.

B. Factory-fabricated with cast bronze body meeting ASTM B584 and galvanized or black steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

2.6 PIPE ROOF CURBS

A. Manufacturers:

1. AES Industries.
2. Custom Curb, Inc.
3. Pate Company.
4. Thybar.

B. Provide factory-fabricated, pipe roof curbs with the following features:

1. Factory installed treated wood nailer.
2. Welded, 18 gauge galvanized steel shell, base plate and flashing.
3. 1-1/2 inch thick, 3 pound rigid insulation.
4. Fully mitered 3-inch raised cant.
5. Cover of weather-resistant, weather-proof material.
6. Pipe collar of weather-resistant material with stainless steel pipe clamps.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

I. Verify final equipment locations for roughing in.

J. Use fittings for all changes in direction and all branch connections.

K. Remake leaking joints using new materials.

L. Install components with pressure rating equal to or greater than system operating pressure.

M. Piping Protection:

1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.3 PENETRATIONS

A. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies. Reference Division 23 Section “Common Work Results for HVAC” for additional penetration requirements.

B. Above Grade Concrete or Masonry Penetrations:

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs.

    a. Provide Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
    b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
    c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

        1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).
        2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

    d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.
3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.

C. Above Ground, Exterior Wall Penetrations:

1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

D. Interior Penetrations of Non-Fire-Rated Walls:

1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

E. Fire / Smoke Rated Floor and Wall Assemblies:

1. Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer’s UL listing. Refer to Division 07 Section “Penetration Firestopping” for special sealers and materials.

3.4 PIPE JOINT CONSTRUCTION

A. Brazed and Soldered Joints:

1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
2. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
3. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
4. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
5. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making joint.
6. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
7. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.
8. Dissimilar metals such as copper and brass shall be jointed using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.
9. Continuously purge the pipe and fittings during brazing with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.
10. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
11. Provide temporary cap or cover on completed joints with open ends to prevent entry of contaminating materials.

B. Joints for other piping materials are specified within the respective piping system Sections.

3.5 UNIONS

A. Install unions on pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

3.6 DIELECTRIC UNIONS

A. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
2. Install waterway fittings where installation is concealed. Do not install dielectric unions in concealed spaces.

3.7 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION 230510

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SECTION 230513 - COMMON MOTOR REQUIREMENT FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

F. Capacitors.

1.2 REFERENCE STANDARDS

A. ABMA STD 9 – Load Ratings and Fatigue Life for Ball Bearings; most recent edition.

B. IEEE 112 – IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; most recent edition.

C. NEMA MG 1 – Motors and Generators; most recent edition.

D. NFPA 70 – National Electrical Code; most recent edition adopted by the Authority Having Jurisdiction, including all applicable amendments and supplements.

1.3 SUBMITTALS

A. Conform with the submittal procedures in Division 01.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Provide nameplate data and ratings, mounting arrangements, size and location of winding termination lugs, overload relays, conduit entry, grounding lug, and coatings.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

E. Operation Data: Include instructions for safe operating procedures.

F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY STORAGE AND HANDLING.

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.6 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Baldor Electric Company.

B. General Electric.

C. Gould.

D. Marathon.

E. Regal-Beloit Corporation (Century).

F. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.

1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
2. Motors 3/4 HP and Larger: Voltage as scheduled, three phase, 60 Hz.

B. Construction:

1. Open drip-proof except where noted otherwise.
2. Design for continuous operation in 104 degrees F environment.
3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. Motors with frame sizes 254T and larger: Energy Efficient Type.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

D. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors where connection is made directly, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.3 APPLICATIONS

A. Exception: Motors less than 250 Watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Single phase motors for fans less than 1 hp and greater than 1/12 hp: Electronically commutated type.

C. Motors located in exterior locations, air cooled condensers,: Totally enclosed fan cooled type.

2.4 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Drip-proof Enclosure: NEMA Service Factor.

G. All motors controlled by variable frequency controllers shall have a 1.15 Service Factor.

H. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

I. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

J. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Division 26 - Motor Controlling Equipment.

K. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: To NEMA MG 1.

M. All totally enclosed motors shall be fan cooled type. Non-ventilated type motors are not acceptable.

N. Motors controlled by variable frequency drives:

1. Rated for voltage peaks and minimum rise times in accordance with NEMA MG1, Part 31.

2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
3. Inverter-Duty Motors: Class B temperature rise; Class F insulation.
4. Grounding: Provide shaft grounding system equal to AEGIS SGR Bearing Protection Ring, Inpro/Seal Current Diverter Ring (CDR) or approved equal. Install system in accordance with manufacturer's recommendations.
5. Motor Overload Relay: When a single drive is used to supply power to multiple motors, provide a solid state 3-phase adjustable overload relay between the drive and each motor.

    a. Relay shall have manual reset.
    b. Provide alarm contact with automatic reset overloads.

O. Part Winding Start, Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

P. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

Q. Nominal Efficiency: Motors shall have minimum NEMA premium efficiency at full load and rated voltage when tested in accordance with IEEE 112.

R. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.5 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.

B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.

C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.

D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

2.6 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 23 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.
2. All welded steel housing.
3. Each capacitor internally fused.
4. Non-flammable synthetic liquid impregnated.

5. Craft tissue insulation.
6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.

D. Install motor overload relays in a common enclosure adjacent to the variable frequency drive

3.2 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.3 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	84	73
2	1200	184T	85.5	75
3	1200	213T	86.5	60
5	1200	215T	87.5	65
7-1/2	1200	254T	88.5	73
10	1200	256T	90.2	74
15	1200	284T	90.2	77
20	1200	286T	91	78
25	1200	324T	91.7	74
30	1200	326T	92.4	78
40	1200	364T	93	77
50	1200	365T	93	79
60	1200	404T	93.6	82
75	1200	405T	93.6	80
100	1200	444T	94.1	80
125	1200	444T	94.1	84
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86.5	86
5	1800	184T	87.5	87
7-1/2	1800	213T	88.5	86
10	1800	215T	89.5	85
15	1800	256T	91	85
20	1800	256T	91	86
25	1800	284T	91.7	85
30	1800	286T	92.4	88
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	88

75	1800	365T	94.1	88
100	1800	404T	94.1	83
125	1800	405T	94.5	86
150	1800	444T	95	85
200	1800	445T	95	85
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	145T	84	85
5	3600	182T	85.5	86
7-1/2	3600	184T	87.5	88
10	3600	213T	88.5	86
15	3600	215T	89.5	89
20	3600	254T	90.2	89
25	3600	256T	91	92
30	3600	284T	91	91
40	3600	286T	91.7	92
50	3600	324T	92.4	89
60	3600	326T	93	91
75	3600	364T	93	88
100	3600	365T	93	88

3.4 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	85.5	65
2	1200	184T	86.5	68
3	1200	213T	87.5	63
5	1200	215T	87.5	66
7-1/2	1200	254T	89.5	68
10	1200	256T	89.5	75
15	1200	284T	90.2	72
20	1200	286T	90.2	76
25	1200	324T	91.7	71
30	1200	326T	91.7	79
40	1200	364T	93	78
50	1200	365T	93	81
60	1200	404T	93.6	83
75	1200	405T	93.6	80
100	1200	444T	94.1	83
125	1200	445T	94.1	85
1	1800	143T	82.5	84

1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	87.5	83
5	1800	184T	87.5	83
7-1/2	1800	213T	89.5	85
10	1800	215T	89.5	84
15	1800	254T	91	86
20	1800	256T	91	85
25	1800	284T	92.4	84
30	1800	286T	92.4	86
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	87
75	1800	365T	94.1	87
100	1800	405T	94.5	86
125	1800	444T	94.5	87
150	1800	445T	95	88
200	1800	447T	95	87
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	182T	85.5	87
5	3600	184T	87.5	88
7-1/2	3600	213T	88.5	86
10	3600	215T	89.5	86
15	3600	254T	90.2	91
20	3600	256T	90.2	89
25	3600	284T	91	92
30	3600	286T	91	92
40	3600	324T	91.7	91
50	3600	326T	92.4	92
60	3600	364T	93	93
75	3600	365T	93	91
100	3600	405T	93.6	92

END OF SECTION 230513

SECTION 230514 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Variable speed drives shall be furnished for those units so indicated on the drawings. All variable speed drives provided under this section shall be by the same manufacturer.

B. Type of variable speed drive specified in this Section include the following:

1. Pulse Width Modulated

1.2 QUALITY ASSURANCE

A. Testing: The variable speed drive, all components and subassemblies shall be factory tested. The variable speed drive shall be tested and cycled under motor load.

B. Reliability: A complete description of supplier's Quality Assurance and Testing program shall be provided.

1. Component Testing: All power semiconductors and integrated circuits shall be 100% tested.
2. Computerized ATE Testing: Computerized Automated Testing Equipment (ATE) testing shall be used to evaluate functional performance of printed circuit boards. Printed circuit boards shall receive a thermal stress test where temperatures are cycled between 0°C and 65°C and receive electrical power-on and power-off cycle tests.
3. Burn In: All VFD's shall be tested/run in the equivalent of a indoor NEMA 1 or outdoor NEMA 3R enclosure and burned in at rated ambient (40°C) with a fully loaded motor.

1.3 CODES AND STANDARDS:

A. The VFD shall meet the following standards.

1. Institute of Electrical and Electronic Engineers (IEEE)

a. Standard 519-2014 IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

2. Nationally recognized testing lab such as UL or ETL

a. UL 508C (Variable frequency drive)
b. UL 508A (Bypass)

3. NEMA – ICS 7.0, AC Adjustable Speed Drives

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product Data: Submit manufacturer's technical product data for variable speed drive including dimensions, capacities, component performance data, ratings, features, motor electrical characteristics, over current protection rating, gages and finishes of material, and installation instructions.

2. Shop Drawings: Submit assembly-type shop drawings including unit dimensions, required clearances, control description, construction details, and field connection details.
3. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to variable speed drives. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
4. Maintenance Data: Submit maintenance instructions, including instructions for adjustments, troubleshooting, operation, testing and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 1 and Division 23 Section “General Mechanical Requirements.”
5. Harmonic Analysis Report: Provide project-specific calculations and manufacturer’s statement of compliance with IEEE 519.

1.5 WARRANTY

A. Provide warranty including on site parts and labor for minimum 36 months from date of shipment.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL:

A. Provide factory assembled and factory tested variable speed drives as indicated, of sizes and capabilities as scheduled, and as specified herein.

2.2 MANUFACTURERS:

A. Subject to compliance with requirements, manufacturers offering variable speed drives which may be incorporated in the work are limited to the following:

1. ABB.
2. Danfoss.
3. Eaton/Cutler-Hammer.
4. Franklin Control Systems.
5. Invertek.
6. Square D, a division of Schneider Electric.
7. Yaskawa Electric America.

2.3 VARIABLE FREQUENCY DRIVES

A. The VFD shall provide the following design features as standard:

1. Input Section: Full wave rectification shall be achieved with input diodes in a conventional bridge configuration and shall be used to supply voltage to the DC bus. Drive shall be provided with dual DC bus chokes or AC line reactors, as required, for a total input impedance of 5% or better.
2. Output Section: The inverter shall use power transistors to provide three phase output power to the motor.
3. Input Displacement Power Factor: The input displacement power factor shall be 0.97 or higher at all operating speeds and loads.
4. Microprocessor Logic: The VFD shall be microprocessor based and utilize digital input for all parameter adjustments. Use of potentiometers for parameter adjustment is not acceptable.
5. Auto Restart: The VFD shall automatically attempt to restart after a malfunction or an interruption of power. The number of attempted restarts shall be customer selectable (0 to

5). If the drive reaches the limit of restarts without successfully restarting and running for a customer selectable length of time (60 to 600 seconds), the restart circuit shall lockout and shall provide contact annunciation. Delay between attempts to restart shall be customer selectable from 3 to 300 seconds.

6. Current Limit: A current limit circuit shall be provided to limit motor current to a preset adjustable maximum level by reducing the drive operating speed or acceleration rate when the limit is reached. Range of adjustment shall be from 50 to 110%.
7. Digital Output Displays and Input Parameter Programming: The VFD shall include a digital display and digital input programming capability on the main logic board. The display shall be programmable for indication of output speed in rpm, frequency, and percent of base speed, motor amps, output motor volts, and output load. The display shall also function as a first fault indicator.
8. Critical Frequency Avoidance (Frequency Jump Points): The VFD shall provide selectable frequency jump pointsto be used to avoid critical resonance frequencies of the mechanical system.
9. Input Signal Follower: The input signal follower circuit shall have selectable differential inputs and accept an electrical speed command from an external source rated at 4-20 mA or 0-10Vdc. The input follower circuit shall be capable of operating directly or inversely proportional to the listed speed commands.
10. Motor Overload Protection: Electronic motor protection shall be provided which is capable of predicting motor winding temperature based on inputting specific parameters including motor design type (TEFC, ODP, or other) and speed range. The protection shall provide an orderly shutdown should the motor's thermal capabilities be exceeded. This protection also eliminates the requirement for motor overload relays on single motor applications when a bypass is not used.
11. Open Collector Outputs: The VFD shall include three (3) open collector outputs to indicate drive run, drive fault, and drive ready.
12. Output Signals: The VFD shall include analog output signals for output load, output speed, instantaneous kw and motor voltage. The signals shall be 4-20 ma or 0-10 Vdc @ 1 mA.
13. Stop Mode Functions: The VFD stopping mode functions shall be selectable for coast-to-rest or stopping at programmed deceleration rate.
14. V/Hz Profiles: The VFD shall provide selectable V/Hz profiles.
15. Loss of Control Signal: The VFD shall revert to the last speed on loss of input control signal. Owner shall be able to field select a preset speed for the VFD to run when control signal is lost, if preferred. In either case, an open collector output shall be selected to indicate loss of control signal for remote indication purposes.

B. The VFD supplier shall provide the same design/technology to cover the HP range for all VFD's.

C. Output Ratings: The VFD shall operate within the following ratings:

1. Frequency range: 1-120 Hz
2. Overload rating: 110% for one minute

D. Motor Performance: The VFD shall provide 3% speed regulation.

E. Input Power: The VFD shall operate within (+5%/-10%) of the nominal rated voltage.

F. Set-up Adjustments: Standard setup adjustments shall include:

1. Minimum speed: 0 to 100%
2. Maximum speed: 0 to 100%
3. Linear accel: 0.5 to 600 seconds
4. Linear decel: 0.5 to 600 seconds
5. Maximum output voltage: Adjustable
6. V/Hz: Adjustable with selectable profiles

7. Current limit: 50 to 110%

G. Environmental Ratings: The VFD shall operate within the following parameters without the requirement for derating:

1. Operating temperature: 0°C to 40°C
2. Altitude: Up to 1000m (3300 ft.)
3. Humidity: 95% non-condensing

H. Enclosure: Refer to VFD schedule or drawings for enclosure type. At minimum, the enclosure shall be suitable for environment installed. Finned heatsinks and/or cooling fans shall be provided as necessary for proper heat dissipation.

I. Protective Features: The VFD shall be designed to meet the following specifications and operate within the following parameters:

1. AC Input Overcurrent Protection: The VFD's power circuit shall be isolated internally with respect to ground and provided with a 100,000 AIC interrupting rated input circuit breaker. As an alternate to the circuit breaker, fuses may be used to accomplish the 100,000 A interrupting rating.
2. Logic Common: The power unit's logic common shall be at ground potential.
3. Phase Loss Protection: Phase loss protection shall be provided to prevent single phasing.
4. Power Loss Ride-Through: The VFD shall be capable of continued operation during an intermittent loss of power. Opening of the VFD's input and/or output line switches while operating shall not result in damage to the power circuit components.
5. Short Circuit and Ground Fault Protection: The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. The VFD must be capable of withstanding short circuits at nominal rated voltage plus 10%(i.e., 480V rated drive + 10% = 528V short circuit voltage). The VFD shall be capable of providing 110% motor current intermittently. The VFD shall include an instantaneous overcurrent trip and shall not restart after electronic overcurrent trip until reset through the run/stop circuit, or unless the auto restart function has been enabled.
6. Transient and Surge Voltage Protection: Transient and surge voltage protection shall be provided through the use of Metal Oxide Varistors (MOVs). The VFD shall withstand a 6000 volt, 80 joule surge voltage when tested in accordance with UL 1449 with the test circuit adjusted for a 2100 amp peak 8x20 us short circuit discharge current pulse.
7. Rotating Motor Start: The VFD shall be able to start into a motor rotating in either direction and at any speed, and accelerate to set speed without any time delay, tripping or component loss.
8. DV/DT Filters: Dv/dt filters shall be provided per the VFD schedule, or if recommended by the VFD manufacturer to ensure that the VFD is applied correctly and to maintain the manufacturer’s full warranty.

J. Maintainability

1. All control circuit voltages (12VAC, 24VDC, 160VDC and 120VAC) shall be physically and electrically isolated from power circuit voltages (200 to 600VAC, 600VDC) to ensure safety to maintenance personnel.
2. The VFD shall be furnished with an alphanumeric diagnostic display with fault indications to include the following: bus overvoltage, bus undervoltage, overcurrent, overtemperature, ground fault, and timed overload.
3. VFD shall be capable of starting and operating without a motor connected for ease of service.
4. All setup and operating parameters shall be stored in nonvolatile memory. The static memory module shall be to be removed and installed in replacement logic boards with all setup and operating parameters intact requiring no adjustment of replacement boards.

K. Communications

1. The VFD shall have an RS-485 port as standard. The standard protocols shall be BACnet, Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
2. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the building management system to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The building management system shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The building management system shall also be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.
3. The VFD shall allow the building management system to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the building management system.
4. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

L. Required Optional Features

1. Operator Panel: A door-mounted Softouch Operator Panel shall be included with the following features:

    a. Shall digitally display motor speed, load, amps, and output volts. (and controller setpoint and system pressure when setpoint controller is included).
    b. Shall have indication for drive run, drive ready, drive fault, plus operator function/status indication such as auto speed reference, and auto restart.
    c. Shall provide selection for Hand/Off/Auto control. In Hand mode, the VFD shall be started and stopped from the operator's panel. In the Auto mode, the VFD shall be started and stopped by remote contact closure. In the Off mode, the VFD shall be locked out.
    d. Shall provide selection for Manual/Auto Speed Reference. In the Manual Reference mode, the VFD speed reference shall be set from the operator's panel. In the Auto Reference mode, the VFD speed reference shall be set by the external source instrument signal. Selecting between Manual and Auto speed reference shall have no bearing on the Hand/Off/Auto start/stop selector, or vice versa.
    e. Shall name all parameters in English, not codes or numbers.

f. Keypad shall include electronic lock-out feature to prevent unauthorized personnel from parameter access.
g. Shall store from three to six drive faults in a history batch file in the order they occur to simplify trouble-shooting. This file will automatically be updated should new faults occur.

2. Input Overcurrent Protection Device: The operating mechanism shall be designed so that the door can be padlocked in the "OFF" position.
3. Elapsed Time Meter: Meter shall provide indication of how long the drive has been running.
4. Firestat/Freezestat: VFDs for air system fans requiring shutoff from safety devices per sequences of operation shall provide terminals for connecting normally closed remote safety devices. This emergency shutdown shall operate in any mode of operation.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which variable speed drive is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION

A. General: Install systems and materials in accordance with manufacturer's instruction.

B. Maintain minimum clearance of 12 inches on each side and 36 inches in front of the variable speed drive.

C. Install variable speed drive in the vertical position.

D. Provide separate conduits for input and output power cables.

E. Provide separate conduits for control cables and the output cables to the motor.

F. Install power and control cabling in separate conduits.

G. Provide dedicated conduits for power cables to the motors.

H. Load Side Disconnects: Provide a disconnect switch on the load side of the VFD near the motor for ease of service and safety. Disconnect switch shall be lockable in the open position when the VFD is not within sight of the motor. Operating the switch with the VFD running shall not cause any component failure. In dual motor applications, VFD shall be able to operate either motor with the other motor disconnected without requiring jumpers, parameter modifications, or other adjustments. As part of start-up, VFD supplier shall certify all load side disconnects can be opened or closed with drive running at full speed without damage to the drive.

1. When a separate disconnect is provided at the motor, provide auxiliary contact in the disconnect switch that will shut down the variable speed drive when the disconnect switch is turned off.

3.3 START UP

A. All units shall be started up at the jobsite by a factory trained and authorized representative.

3.4 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter written by the Contractor stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided. Copies of the startup report shall be attached to the certification letter.

D. Schedule: Schedule training with Owner with at least 14 days' advance notice.

END OF SECTION 230514

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SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components.

B. Horizontal piping hangers and supports.

C. Saddles and shields.

D. Vertical piping clamps.

E. Pipe alignment guides.

F. Pipe anchors.

G. Pre-engineered roof pipe supports.

H. Pre-engineered roof equipment supports.

I. Anchors and fasteners.

J. Miscellaneous materials.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.

C. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."

D. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.

1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

E. Installer's Qualifications: Include evidence of compliance with specified requirements.

F. 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.

G. Deferred Submittals: Submit signed and sealed drawings that indicate the design and installation requirements of pre-engineered roof supports can withstand the design criteria listed in this specification. Include installation requirements for anchoring to the roof structure. The Engineer is not responsible and will not provide the seal and signature. Deliver submittal to the local AHJ for approval prior to installation of the contractor provided, pre-engineered roof supports.

1.4 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

E. Deferred Submittals: Signed and sealed by a professional engineer or National Institute for Certification in Engineering Technologies (NICET) stamp and signature. The professional engineer shall be licensed in the same state in which the project is located.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS AND MATERIALS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.

2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.

    a. Indoor Dry Locations: Carbon steel, galvanized steel, zinc-plated steel or approved equivalent where installed for piping and equipment that will not have a factory-applied or field-applied finish, unless otherwise indicated.
    a. Indoor Damp or Wet Locations: Galvanized steel, painted steel, Type 304 stainless steel, or aluminum.
    b. Outdoor Locations: Type 304 stainless steel, galvanized steel, aluminum, or approved equivalent.
    c. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
    d. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    e. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
    f. Stainless Steel: Type 304 in accordance with ASTM A240.

B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:

    a. Cooper B-Line.
    b. Ferguson Enterprises/FNW.
    c. PHD Manufacturing.
    d. Thomas & Betts Corporation.
    e. Unistrut, a brand of Atkore International Inc.
    f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.
4. Channel Material:

    a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
    b. Outdoor and Damp or Wet Indoor Locations: Use stainless steel, aluminum, or galvanized steel.
    c. All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.
6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.
7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Threaded zinc-plated steel, threaded both ends or continuously threaded, unless otherwise indicated.
2. Minimum Size: Reference piping specification sections for rod thicknesses.
3. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Manufacturers:

1. Armacell.
2. Anvil International.
3. Cooper B-Line, Inc.
4. Elite Components.
5. ERICO/Michigan Hanger Co./Caddy
6. Ferguson/FNW.
7. Halfen-DEHA.
8. Hilti.
9. National Pipe Hanger Corporation.
10. PHD Manufacturing.
11. Power-Strut.
12. Unistrut.

B. Single Hangers:

1. Band Hanger: Carbon steel, adjustable band, adjustable swivel.
2. Split Ring: Carbon steel, adjustable swivel, split ring type.
3. Clevis Hanger: Carbon steel, adjustable, clevis type.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.

D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:

1. Manufacturers:

a. Anvil International.
b. Holdrite.
c. Klo-Shure.

2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.

E. Spring Hangers:

1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for spring isolation hangers.

F. Wall Supports:

1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.

G. Floor Supports:

1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

H. Pre-Insulated Supports:

1. Manufacturers:

a. Aeroflex USA, Inc.
b. Armacell.
c. Buckaroos, Inc.
d. Cooper B-Line, Inc.

2. General Construction and Requirements:

a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.
b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
c. Waterproof calcium silicate insulation shall conform to ASTM C795.
d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.
e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.

3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.3 SADDLES AND SHIELDS

A. Pipe Covering Protection Saddles:

1. Manufacturers: Same as hanger and Supports.
2. Meet MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12 inches and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12 inches long.

B. Insulation Protection Shield:

1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.
2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in) 5	6	7	8	9	10
		Hanger Spacing, (ft)					
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
≤ 2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

C. 360 Degree Insulation Protection Shield:

1. Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

D. Plastic Saddles and Shields:

1. Manufacturers:

a. Armacell.
b. Eaton.
c. Hydra-Zorb.
d. PHD Manufacturing.
e. Zsi Foster.

2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.4 VERTICAL-PIPING SUPPORTS

A. Manufacturers:

1. Armacell.
2. Anvil International.
3. Cooper B-Line, Inc.
4. Halfen-DEHA.
5. Hilti.
6. ERICO/Michigan Hanger Co.
7. National Pipe Hanger Corporation.
8. PHD Manufacturing.
9. Power-Strut.
10. Unistrut.

B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.
2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.

C. Riser Clamps with pre-manufactured polymer insert:

1. Manufacturers:

a. Hydra-Zorb; Titan Riser Clamp.
b. National Pipe Hanger.
c. Approved equal.

2. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

2.5 PIPE ALIGNMENT GUIDES

A. Factory fabricated, constructed of cast semi-steel or heavy fabricated steel when applied to steel pipe and copper when applied to copper. Guide shall consist of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.
2. Pipe Diameter 10 inches and Larger: Roller type.
3. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.

2.6 PIPE ANCHORS

A. Pre-Insulated Anchors: Carbon steel or stainless steel assembly with high density insulation insert and no metal-to-metal contact.

B. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

2.7 PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Manufacturers:

1. Airtec.
2. Anvil International.
3. Cooper B-Line, Inc.
4. Elite Components.
5. ERICO/Michigan Hanger Co./Caddy.
6. Ferguson/FNW.
7. Miro.
8. PHP Systems/Design.
9. PHD Manufacturing.
10. Roof Top Blox.
11. Unistrut, a brand of Atkore International Inc.
12. Zsi Foster.

B. General: Pre-engineered devices with embedded pipe support fixtures as specified.

C. Pedestals: Steel pedestals with thermoplastic or rubber base with the following dimensions:

1. Up to 12 inch strut length support: 18 inch x 18 inch.
2. Up to 16 inch strut length support: 24 inch x 18 inch.
3. Up to 24 inch strut length support: 30 inch x 18 inch.
4. Thickness: Minimum 3/16 inch thick.

D. Block Bases: Closed-cell polyethylene blocks with the following dimensions.

1. Length: Nominal 10 inch, 12 inch, 16 inch, or 24 inch
2. Width: Nominal 4 inches.

E. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.

F. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

2.8 PRE-ENGINEERED ROOF EQUIPMENT SUPPORTS

A. Reference Section “Vibration Isolation for HVAC” for vibration isolated pre-engineered roof equipment supports.

B. Manufacturers: Subject to compliance with requirements, provide roof equipment supports from the equipment manufacturer or from one of the following:

1. AES Industries.
2. Caldyn, California Dynamics Corp.
3. Custom Curb, Inc.
4. Kinetics Noise Control.
5. Mason Industries, Inc.
6. Pate Company.
7. Thybar.
8. Vibration Eliminator Co., Inc.
9. Vibration Mounting and Controls (VMC Group).
10. Vibro-Acoustics.

C. Single Rail Equipment Supports:

1. Construction:

a. Base plate with fully mitered raised cant and step to match roof insulation thickness.
b. Welded, minimum 18 gauge galvanized steel shell, internally reinforced to load bearing factors of equipment being supported.
c. Factory installed treated wood nailer.
d. 4 inch, minimum 18 gauge nailer jacket with counterflashing where equipment will not fully cover the equipment support.

D. Roof Curbs:

1. Construction:

a. Comply with NRCA standards.
b. Base plate with fully mitered raised cant and step to match roof insulation thickness.
c. Welded, minimum 18 gauge galvanized steel shell, internally reinforced to load bearing factors of equipment being supported.

d. Minimum 1-1/2 inch thick, 3 pound density rigid insulation internal to shell to maintain continuous roof insulation.
e. Factory installed treated wood nailer and drain nipple.
f. Sloped to match roof structure to enable level installation.

2.9 ANCHORS AND FASTENERS

A. Manufacturers:

1. Hilti, Inc.
2. Illinois Tool Works, Inc.
3. Phillips.
4. Powers Fasteners, Inc.
5. Rawl.
6. Simpson Strong-Tie Company Inc.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.
2. Solid or Grout-Filled Masonry: Use expansion anchors.
3. Hollow Masonry: Use toggle bolts.
4. Hollow Stud Walls: Use toggle bolts.
5. Steel: Use beam clamps.
6. Sheet Metal: Use sheet metal screws.
7. Wood: Use wood screws.
8. Plastic and lead anchors are not permitted.
9. Hammer-driven anchors and fasteners are permitted only as follows:

a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Comply with MFMA-4.
2. Channel Material: Use galvanized steel.
3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rode dimensions.
5. Manufacturers:

a. Same as manufacturer of metal channel (strut) framing system.
b. DeWalt “Bang-It” concrete inserts.

D. Post-Installed Concrete and Masonry Expansion Anchors:

1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.

E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

F. Vibration Isolation Anchors: Reference Section “Vibration Isolation for HVAC Piping and Equipment” for vibration isolation anchors.

2.10 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Division 23 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.
3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
4. Refer to Section 230700 for definition of hot and cold piping and required insulation thickness.

H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 23 piping sections.

1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

    a. Uninsulated Copper Pipe: Install with plastic galvanic isolators
    b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section "HVAC Insulation".

I. Install building attachments within concrete or to structural steel.

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.
2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

K. Install appropriate types of hangers and supports to allow controlled 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.

L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

N. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamps, including spacers (if any), to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 23 Section “HVAC Insulation”.
2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
3. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 23 Section “HVAC Insulation”. Do not use polymer-based shields for hot piping.

    a. Exception for horizontal cold piping with fiberglass, cellular glass, flexible elastomeric, or polyisocyanurate insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.

4. Contractor’s Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.
5. Contractor’s Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer’s recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer’s recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section “HVAC Insulation”.

P. Vertical Piping Risers:

1. Reference Section “Vibration Isolation for HVAC Piping and Equipment” for piping riser supports.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper 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 anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 INSTALLATION OF PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Install pre-engineered roof pipe supports to rest on the roofing membrane without attachment to the roof structure or penetration through the roofing assembly.

B. Install pre-engineered roof pipe supports anchored to the roof structure.

1. Install supports to meet the specified design criteria.

    a. Building Design Risk Category: II.
    b. Design Wind Speed: 115 mph.

2. Coordinate with the pre-engineered roof pipe support manufacturer to anchor the pipe supports directly to the roof structure in accordance with the manufacturer's installation instructions or provide intermediate pipe supports engineered to meet the design criteria.
3. Submit design and installation requirements as a Deferred Submittal.

C. Refer to Section "Seismic Controls for Mechanical" for seismic bracing requirements.

3.6 INSTALLATION OF ROOF EQUIPMENT SUPPORTS

A. Attach roof equipment support to the roof structure according to the manufacturer's installation instructions.

B. Provide multiple single rail equipment supports to uniformly support the equipment.

C. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope.

D. Install supports to maintain continuous insulation on roof.

E. Provide vibration isolators between roof equipment support and equipment according to Division 23 Section "Vibration Isolation for HVAC."

F. If vibration isolation is not required or units are internally isolated, attach equipment directly to pre-engineered roof equipment support using one of the following:

1. Single Rail Equipment Supports: Secure each equipment support leg to the rail with a minimum of 4 points of connection per leg.
2. Roof Curbs:

    a. Secure each corner of the equipment to the curb nailer using a minimum of 4 lag screws, located along the length of the equipment.
    b. Secure equipment to the curb using hold-down brackets. Provide minimum 6 inch long, 14 gauge galvanized steel brackets sized to wrap around top of curb and under equipment base rail with sufficient horizontal offset to cover overlap gap between the equipment rail and curb. Secure bracket to equipment and curb nailer using a minimum of 8 points of connection per bracket. Provide one bracket at each corner along the length of the unit.

3. Hold-Down Brackets: Coordinate with the pre-engineered roof equipment support manufacturer to determine the quantity and size of hold-down brackets and fasteners, with installation instructions, for each equipment to meet the following criteria:

    a. Building Design Risk Category: II.
    b. Design Wind Speed: 115 mph.

c. Submit design and installation requirements as a Deferred Submittal.

G. Refer to Section “Seismic Controls for Mechanical” for seismic bracing requirements.

3.7 EQUIPMENT SUPPORT AND ATTACHMENT

A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.

C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.

F. Secure fasteners according to manufacturer's recommended torque settings.

G. Remove temporary supports.

H. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.

I. Grouting: Place grout under supports for piping and equipment.

3.8 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

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 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.9 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section “Painting.”

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.10 PIPE HANGER AND SUPPORT SCHEDULE

A. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

B. Single Hangers:

1. All pipe sizes 1-1/2 inch and less:

a. Band hanger.
b. Swivel split ring.
c. Clevis hanger.

2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.

C. Trapezes and Strut-mounted Supports:

1. All pipe sizes less than 6 inches: Two-piece clamp.

D. Wall Supports:

1. Pipe sizes 3 inches and less:

a. Two-hole strap mounted to wall.
b. Welded steel bracket with reinforced angle or strut.

2. Pipe sizes 4 inch and greater:

a. Welded steel bracket with reinforced angle or strut.

E. Floor Supports:

1. Pipe sizes 4 inch and less: Pipe saddle.

END OF SECTION 230529

SECTION 230548 - SEISMIC CONTROLS FOR MECHANICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

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 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 20 Section “Seismic Controls for MEP/F/T Systems” for general requirement and related documents that apply to this section.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.4 SUMMARY

A. Seismic bracing, restraints, and controls for all mechanical systems specified herein shall be designed and installed as required by Division 20 Section “Seismic Controls for MEP/F/T Systems”.

1.5 SUBMITTALS

A. Provide submittals as required by Division 20 Section “Seismic Controls for MEP/F/T Systems” for all mechanical systems specified herein.

PART 2 - PRODUCTS AND MATERIALS
Not Used

PART 3 - EXECUTION
Not Used

END OF SECTION 230548

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SECTION 230550 - VIBRATION ISOLATION FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vibration isolation requirements.

B. Vibration isolators.

1.2 COORDINATION

A. Contractor's Responsibility:

1. Verify the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.
2. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.
3. Coordinate selection and arrangement of vibration isolation components with the actual equipment to be installed.
4. Coordinate the work with other trades to provide additional framing and materials required for installation.
5. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
6. Sequencing:

    a. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

B. Manufacturer's Responsibility:

1. Determine vibration isolation types for all equipment and systems in accordance with the local governing code.
2. Calculate the static deflection requirements for all equipment and systems to provide uniform deflection based on distributed operating weight of actual installed equipment.
3. Select the vibration isolation systems to provide static deflection indicated on the Vibration Isolation Schedule and as specified below. Determine the mounting sizes and layout.
4. Guarantee specified isolation system deflection.
5. Provide installation instructions, drawings and field supervision to ensure proper installation and performance.
6. Verify that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer’s standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.

1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities. Include clearly outlined procedures for installing and adjusting the isolators.

B. Shop Drawings:

1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators on each piece of isolated equipment. Indicate equipment weights and static deflections.
2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable. Indicate equipment mounting provisions.
3. Piping isolators shown and identified on piping layout drawings.
4. Concrete foundations, supports, and required reinforcing and forms. These appurtenances shall be provided by another trade. This trade shall furnish the shop drawings, including the following:

    a. Concrete reinforcing steel details and templates for all foundations and supports.
    b. Required hanger bolts.
    c. All other appurtenances necessary for proper installation of equipment.

C. Vibration Isolation System Schedule: Include the following for each isolation element:

1. Manufacturer, isolator type, model number, size.
2. Height when uncompressed and static deflection.
3. Spring constant.
4. Spring outside diameter, free operating, and solid heights.
5. Design of supplementary bases.
6. Details of attachment to load-bearing structure or supplementary framing.

D. Post-Installation Inspection Report:

1. Vibration isolation vendor notice of inspection of all vibration isolators.
2. Vibration isolation vendor notice of approval that all vibration isolators have been properly installed and conform to the specification.
3. Itemized list of deficiencies.
4. Vibration Isolation System Schedule.
5. For each isolator containing steel springs, record the following:

    a. Size.
    b. Uncompressed height.
    c. Design static deflection.
    d. Measured static deflection.

1.4 QUALITY ASSURANCE

A. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.

B. All vibration isolation equipment and materials shall be new and manufactured specifically for the purpose intended.

C. Maintain at the project site a copy of each reference document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. BRD Noise and Vibration Control.

B. Caldyn, California Dynamics Corp.

C. Kinetics Noise Control.

D. Mason Industries, Inc.

E. Vibration Eliminator Co., Inc.

F. Vibration Mounting and Controls.

G. Vibro-Acoustics.

2.2 VIBRATION ISOLATION REQUIREMENTS

A. Construct vibration isolators out of resilient materials resistant to oil, ozone, and oxidant.

B. Select vibration isolators to provide the static deflection as specified in Part 2 "Products" unless otherwise specified for the application listed in Part 3 "Execution."

C. Where a pipe run connects multiple equipment, select the pipe isolators for the entire run to suit the connected equipment of greatest static deflection.

D. Vibration isolators shall have either known undeflected heights or calibration markings so that the amount of deflection can be verified after adjustment to determine that the load is within the proper range of the device and that the correct degree of vibration isolation is provided according to the design.

E. Vibration isolators, base frames, and inertia bases shall provide uniform deflection and stability under all operating loads.

F. Isolators for fans shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

G. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.

H. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than plus/minus 10 percent.

I. All elastomeric mountings shall have a Shore hardness of 30 to 60 plus/minus 5 after minimum aging of 20 days or corresponding over-aging, or as specified herein.

J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated of natural rubber instead of neoprene.

K. Equipment mounted on vibration isolated bases shall have minimum operating clearance of 1 inch between the base and floor or support beneath unless noted otherwise.

L. Vibration Isolator Assemblies with Steel Springs:

1. Housed or caged spring isolators are not acceptable.
2. Assemblies shall use bare springs, color coded or otherwise identify springs to indicate load capacity.
3. Spring diameter shall not be less than 0.8 of the loaded operating height of the spring.
4. The ratio of the horizontal to vertical spring constant shall be between 1 and 2.
5. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
6. Assembly shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation.
7. Springs shall operate in the linear portion of their load versus deflection curve over a deflection range of not less than 50 percent above the design deflection.

M. Vibration isolators exposed to weather and other corrosive environments shall be protected with factory corrosion resistance.

1. Exterior applications:

a. Springs: Cadmium-plated and neoprene coated.
b. Nuts and bolts: Cadmium plated.
c. Other metal mounting parts: Hot-dip galvanized.

2. Interior applications: Painted.

2.3 VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

A. Pre-Engineered Roof Equipment Support (Type RES):

1. Reference Section “Hangers and Supports for HVAC Piping and Equipment” for specification of non-vibration isolated, pre-engineered roof equipment supports.

2.4 VIBRATION ISOLATORS

A. Ribbed Neoprene “Waffle” Pads (Type WP):

1. Assembly: Single ribbed or crossed double ribbed elastomer in-shear pads, in one or more layers separated and bonded to a minimum 1/4 inch thick galvanized steel shim plate as required to provide selected deflection.
2. Thickness: Each layer 5/16 inch thick.
3. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.05 inches.
4. Type WP: Mason Industries Type W, Type WSW, or approved equal.

B. Double Deflecting Neoprene Mounts (Type DDNM):

1. Assembly: Laterally stable, double deflecting, neoprene encapsulated mount with bolt holes for attachment to supporting structure.
2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.
3. Type DDNM: Mason Industries Type ND or approved equal.

C. Restrained Neoprene Mounts (Type RNM)

1. Assembly: Restrained neoprene mounting element encapsulated in a metal housing to prevent bulging of the neoprene element with bolt holes for attachment to supporting structure. Assembly shall be designed to provide isolation in tension, shear or compression.
2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.25 inches.
3. Type RNM: Mason Industries Type RBA or approved equal.

D. Steel Spring Neoprene Mounts (Type SPNM):

1. Assembly: Single or multiple free-standing and laterally stable steel springs without a housing.

    a. Light capacity base: Molded elastomeric neoprene load plate.
    b. Heavy capacity base: Springs welded to the load plate assembly furnished with integral elastomeric pad.
    c. Leveling Device: Rigidly connected to equipment or frame.

2. Selection:

    a. Minimum static deflection for equipment mounted on grade slabs shall be 1 inch unless specified otherwise.
    b. Minimum static deflection for equipment mounted above grade (suspended) slabs shall be 2 inches unless specified otherwise.

3. Type SPNM: Mason Industries Type SLFH or approved equal.

E. Neoprene Bushing (Type NR):

1. Assembly: Neoprene restraint, rubber-in-shear bushings for lightweight, suspended equipment supported from structure with all-thread rod and angle iron or Unistrut.
2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.15 inches.
3. Type NR: Mason Industries Type HMIB or approved equal.

F. Spring and Neoprene Hanger (Type SPNH)

1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator in series with a steel spring.

    a. Housing: Include a neoprene bushing to prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function. Bottom opening sized to allow hanger rod to swing through a 30 degree arc.

2. Selection:

    a. Neoprene isolator: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.

b. Spring isolator: Minimum static deflection of 2 inches unless specified otherwise.

3. Type SPNH: Mason Industries Type 30N or approved equal.

G. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.

H. Flexible Connectors:

1. Pipe: Refer to Section “Hydronic Piping Specialties.”
2. Duct: Refer to Section “Air Duct Accessories.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting surfaces are ready to receive vibration isolation and associated attachments.

3.2 INSTALLATION - GENERAL

A. Install in accordance with manufacturer’s instructions.

B. External spring isolators are not required if unit is provided with internal spring isolation. If external spring isolators are provided, internal spring isolation shall not be approved.

C. Mount or suspend all equipment, piping, ductwork, etc. from approved foundations and supports as specified herein or as shown on the drawings.

D. Secure fasteners according to manufacturer’s recommended torque settings.

E. Support piping, ductwork, conduit, and mechanical equipment building structure. Do not support from other equipment, piping, or ductwork.

F. Install isolators to prevent short-circuiting of the isolation.

G. All wiring connections to mechanical equipment on isolators shall have a minimum 18 inch long flexible conduit in a “U” shaped loop. Coordinate with Division 26.

H. Flexible Connectors: Install flexible connectors sized to match equipment connections and to provide sufficient slack for vibration isolation as required.

I. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Block-up equipment with temporary shims to final operating height. When the system is assembled full load is applied, adjust the isolators shall be adjusted to allow shim removal.

J. Refer to Division 23 Section “Seismic Controls for Mechanical” for seismic bracing requirements.

3.3 INSTALLATION OF VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

A. All floor-mounted equipment shall be erected on housekeeping pads. Refer to Section “Common Work Results for HVAC” for concrete housekeeping pad requirements.

B. Maintain minimum 4 inches clearance between isolated equipment and the walls, ceiling, floors, columns, and any other equipment not installed on vibration isolators.

C. Set steel bases for one inch clearance between housekeeping pad and base.

D. Adjust equipment to be level.

E. Verify no material is left to short-circuit the isolator.

F. For equipment support bases installed on the roof, coordinate with the pre-engineered roof equipment support manufacturer to determine the quantity and size of hold-down brackets, isolators, and fasteners, with installation instructions, for each equipment to meet the following criteria:

1. Building Design Risk Category: II.
2. Design Wind Speed: 115 mph.

3.4 INSTALLATION OF VIBRATION ISOLATORS

A. Neoprene Mounting Sleeves, Grommets, and Bushings: Install on vibration isolators to prevent any metal to metal contact.

B. Spring Isolators:

1. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
2. Install springs so that the ends of springs remain parallel and all springs are installed with adjustment bolts.
3. Locate isolation hangers at the top of hanger rods.
4. Type SPNM: Unless otherwise specified, isolators need not be bolted to the floor for indoor installations.
5. Type SPNH: Install the hanger box to allow it to rotate a full 360 degrees without encountering any obstruction.

3.5 EQUIPMENT ISOLATION

A. Air Handling Units:

1. Units that are furnished with internal structural frames and external lugs (both of suitable strength and rigidity), or without any severe overhangs, do not require an additional structural frame installed beneath the unit.
2. Support condensate drain pipes from the isolated air handling unit frame.
3. Slab-on-Grade: Housekeeping pad base, Type SPNM isolation with 1 inch static deflection.
4. Suspended: Type SPNH isolation with 2 inch static deflection.

B. Packaged Rooftop Units:

1. Slab-on-Grade: Housekeeping pad base, Type WP isolation continuous along support.

C. Makeup Air Units, Heating and Ventilating Units, and Other Packaged Air Conditioning Units:

1. Slab-on-Grade: Housekeeping pad base, Type SPNM isolation with 0.75 inch static deflection.

D. Air-Cooled Condensers and Condensing Units:

1. Slab-on-Grade: Housekeeping pad base, Type WP isolation continuous along support.

E. VAV Terminal Units:

1. Fan-Powered: Flexible duct connectors with Type SPNH isolation with 1 inch static deflection.
2. All other Types: Flexible duct connectors.

F. Fans

1. Suspended:

a. Fans 1 hp and less: Type NR isolation with 0.15 inch static deflection.
b. Fans greater than 1 hp: Type SPNH isolation with 2 inch static deflection.

2. Roof-mounted:

a. Curb mounting: Type RES curb base, with closed cell sponge gasket for sealing, continuous along support sealed to curb top rail.

G. Unit Heaters: Type SPNH isolation with 2 inch static deflection.

H. All other equipment not specifically identified in this specification that contains rotating or vibrating elements and any associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM or RNM neoprene isolators as appropriate.

3.6 DUCT ISOLATION

A. Connect ducts to equipment, fans, fan casings, and fan plenums with flexible connectors.

3.7 FIELD QUALITY CONTROL

A. Arrange for inspection of all isolation and noise control equipment by the vibration isolation vendor and submit post-installation inspection report.

B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.

C. Guarantee: If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

END OF SECTION 230550

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Stencils.

D. Pipe markers.

E. Engraved plastic-laminate signs.

1.2 SUBMITTALS

A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.

B. Valve Tag Schedule: Submit 8-1/2 x 11 inch typewritten valve schedule. Furnish one extra copy for each maintenance manual. Include the following information in the schedule:

1. Valve tag number.
2. Piping system and system abbreviation as shown on tag.
3. Location of valve (room or space).
4. Variations for identification (if any).
5. Function. Specially mark valves which are intended for emergency shut-off and similar special uses in margin of schedule.
6. Valve manufacturer's name and model number.

C. Product Data: Submit manufacturer's technical product data for each product required.

D. Manufacturer’s Installation Instructions: Indicate special procedures and installation for each product required.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Advanced Graphic Engraving, LLC.

B. Brady Corporation.

C. Brimar Industries, Inc.

D. Craftmark.

E. Industrial Safety Supply Co., Inc.

F. Kolbi Pipe Marker Co.

G. MIFAB, Inc.

H. Seton Identification Products, a Tricor Direct Company.

2.2 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

A. General:

1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.
2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.
3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).

B. Air Handling Units: Nameplates, stencils, or engraved plastic laminate signs.

C. Air Terminal Units: Tags, stencils, or engraved plastic laminate signs.

D. Automatic Controls: Tags, use the same naming convention coordinated with the building automation system.

E. Control Panels: Nameplates.

F. Fans: Nameplates, stencils, or engraved plastic laminate signs.

G. Heat Transfer Equipment: Nameplates, stencils, or engraved plastic laminate signs.

H. Major Control Components including Variable Frequency Drives: Nameplates or engraved plastic laminate signs.

I. Piping: Pipe Markers.

J. Pumps: Nameplates or engraved plastic laminate signs.

K. Small-sized Equipment: Tags.

L. Tanks: Nameplates or engraved plastic laminate signs.

M. Thermostats: Nameplates.

N. Water Treatment Devices: Nameplates or engraved plastic laminate signs.

O. General Signs: Engraved plastic laminate signs.

2.3 NAMEPLATES

A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and mark number.
2. Equipment service.
3. Design capacity.
4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.

C. Letter Color: White.

D. Letter Height: 1/4 inch.

E. Background Color:

1. Cooling equipment: Green.
2. Heating equipment: Yellow.
3. Combination cooling and heating equipment: Yellow/Green.
4. Energy reclamation equipment: Brown.
5. Equipment and components that do not meet any of the above criteria: Blue.

F. Plastic: Conform to ASTM D709.

2.4 TAGS

A. Plastic Laminate Tags: Laminated three-layer plastic, minimum 3/32 inch thick, with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.

B. Solid Plastic Tags: Solid plastic, minimum 3/32 inch thick, with printed black letters on white color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.

C. Metal Tags: Provide 19-gauge polished brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with black enamel paint.

D. Accident Prevention Tags: Pre-printed or partially pre-printed, of plasticized card stock with matte finish suitable for writing, minimum 3-1/4 inch x 5-5/8 inch size, with brass grommet in hole for fastener. Order with appropriate pre-printed wording (e.g., DANGER, CAUTION, DO NOT OPERATE, etc.).

E. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the size required for proper attachment of tags to valves, manufactured specifically for that purpose.

F. Letter Height:

1. System Abbreviation: Minimum 1/4 inch.
2. Valve Number: Minimum 1/2 inch.

2.5 STENCILS

A. Stencils: With clean cut symbols and letters of following size, complying with ASME A13.1:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.

3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
6. Ductwork and Equipment: 2-1/2 inch high letters.
7. Access Doors: 3/4 inch high letters.
8. Operational Instructions: 3/4 inch high letters.
9. Provide arrows indicating direction of flow.

B. Stencil Paint: Oil based, alkyd enamel, either brushing grade or pressurized spray-can form and grade, black color, except for piping. For piping systems use colors conforming to ASME A13.1.

2.6 PIPE MARKERS

A. Semi-rigid Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum 3 mil thick.

1. Width: 1-1/2 inch for pipes less than 6 inches (including insulation), 2-1/2 inch for pipes 6 inches and larger (including insulation).

C. Pipe Marker with Insulation: 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Insulation shall extend 2 inches beyond each end of plastic pipe marker.

D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

1. Detection: Provide multi-ply tape consisting of solid aluminum foil core between two layers of plastic ribbon tape.

E. Nomenclature: Manufacturer's standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as selected by the Engineer.

F. Arrows: Provide pipe markers with integral arrows indicating direction of flow or as a separate unit of plastic.

G. Color:

1. Conform to .
2. Heating, Cooling,: Green with white letters.
3. Toxic and Corrosive Fluids: Orange with black letters.
4. Compressed Air: Blue with white letters.

H. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

2.7 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate, engraved with manufacturer's standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:

1. Name and mark number.
2. Equipment service.
3. Design capacity.

E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 GENERAL INSTALLATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Install products in accordance with manufacturer's instructions.

C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

D. Apply stencil painting in accordance with Division 09.

E. Identify service, flow direction, and pressure.

3.3 PIPING IDENTIFICATION

A. General: Install identification on the most obviously visible portion of the pipe from the point of access.

B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

C. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe during back-filling/top-soiling of each underground piping system, Where multiple pipes are buried in common trench and do not exceed overall width of 16 inches, install single pipe marker. For tile fields and similar artificial field installations, mark only edge pipe lines of field.

D. Pipes less than 6 inches diameter (including insulation):, Provide full-band pipe markers with 360 degree coverage.

E. Pipes 6 inches diameter and larger (including insulation): Provide either full-band or strip-type pipe markers.

F. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:

1. Within 5 feet of each valve, tee, and control device.
2. Within 5 feet of each branch, excluding branches less than 25 feet in length to fixtures or terminal heating and cooling units.
3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Within 5 feet of equipment outlets and other points of origination and termination.
6. Spaced intermediately at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.

3.4 ACCESS DOOR IDENTIFICATION

A. Provide identification on each access door, indicating purpose of access, maintenance and operating instructions, and appropriate safety and procedural information.

B. Where access doors are concealed above a removeable ceiling system or similar concealment, tags may be used in lieu of specified identification.

3.5 EQUIPMENT IDENTIFICATION

A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:

1. To distinguish between multiple units in close proximity.
2. To inform operator of operational requirements.
3. To indicate safety and emergency precautions.
4. To warn of hazards and improper operations.

B. Adjust lettering size based on viewing distance from normal location of identification:

1. Less than 2 feet: Minimum 1/4 inch.
2. Up to 6 feet: Minimum 1/2 inch.
3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.
4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.

C. Where equipment to be identified is concealed above acoustical ceilings or similar removeable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

END OF SECTION 230553

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SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General testing, adjustment, and balancing requirements.

B. Pre-testing, adjustment, and balancing of existing air systems.

C. Testing, adjustment, and balancing of air systems.

D. Testing, adjustment, and balancing of domestic water systems.

E. This section excludes:

1. Testing boilers and pressure vessels for compliance with safety codes;
2. Specifications for materials for patching mechanical systems;
3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
4. Requirements and procedures for piping and ductwork systems leakage tests.

1.2 DEFINITIONS

A. TAB: Testing, adjusting, and balancing.

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

F. Report forms: Data sheets arranged for collecting test data in logical order for submission and review. Data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

G. Terminal: The point where the controlled fluid enters or leaves the distribution system. Examples include inlets and outlets on water terminals, inlets and outlets from air terminal units, and inlets and outlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

H. Main: Duct or pipe containing the major or entire fluid flow of the system.

I. Submain: Duct or pipe containing part of the system capacity and serving two or more branch mains.

J. Branch main: Duct or pipe serving two or more terminals.

K. Branch: Duct or pipe serving a single terminal.

1.3 SUBMITTALS

A. Qualifications:

1. Submit qualifications of TAB agency.
2. Submit qualifications of TAB supervisor.

B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.

C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.

D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

E. Preconstruction Test Report:

1. Submit preconstruction test report of existing systems as indicated on the drawings. Submit report prior to start of construction on the affected systems for review and comment by the engineer. Reference Part 3 for test procedures.
2. Report format shall follow Draft Report procedures specified above.
3. Report shall include all information requested by the procedures for each system covered by the scope of work. Information omitted or missed during the initial or subsequent pretests shall be documented via additional site visits at no additional cost to the owner.

F. Progress Reports.

G. Certified TAB Reports:

1. General:

a. Submit within two weeks after completion of testing, adjusting, and balancing.
b. Revise TAB plan to reflect actual procedures and submit as part of final report.
c. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

2. Draft Report: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:

a. The systems have been tested, adjusted, and balanced in accordance with the referenced standards.
b. The report reflects an accurate representation of how the systems have been installed.
c. The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.
d. The report is an accurate record of all final quantities measured to establish normal operating values of the systems.

4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, and cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:

    a. General Information and Summary

        1) Include project name, location, altitude, and date.
        2) Identify TAB agency, contractor, owner, architect, and engineer.
        3) Include addresses, contact names, and telephone numbers.
        4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.
        5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.

    b. Air Systems
    c. Temperature Control Systems

5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE 111.
6. Units of Measure: Report data in I-P (inch-pound) units only.

H. Project Record Documents: Provide drawings that record actual locations of flow measuring stations and balancing devices.

1.4 QUALITY ASSURANCE

A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.

B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter “Testing, Adjusting, and Balancing”, most current edition.

C. TAB Agency Qualifications:

1. Act as the single source of responsibility for TAB of the HVAC systems.
2. Staff the project at all times by qualified personnel.
3. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.
4. Certified by one of the following Certification Associations:

    a. AABC (NSTSB): Associated Air Balance Council, National Standards for Total System Balance.
    b. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
    c. TABB: Testing, Adjusting, and Balancing Bureau, SMACNA TAB Procedural Guide.

D. TAB Supervisor and Technician Qualifications:

1. Certified by the same organization as TAB agency.
2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.

PART 2 - PRODUCTS AND MATERIALS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.

B. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.

C. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.

D. 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.

E. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.

F. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.

G. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

H. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Motors and bearings are lubricated.
5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
6. Duct systems are clean of debris.
7. Fans are rotating correctly and belts have tension.
8. Fire, smoke, fire/smoke, and volume dampers are in place and open.
9. Air coil fins are cleaned and combed.
10. Volume dampers are installed at locations needed for balancing the air systems.
11. Access doors are closed and duct end caps are in place.
12. Air outlets are installed and connected.
13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.
14. Hydronic systems are flushed, filled, and vented.
15. Hydronic systems are tested for leaks.
16. Test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves are properly installed and that their location is accessible.

17. Pumps are rotating correctly.
18. Service and balance valves are open.
19. Expansion tanks are not air bound and have appropriate charge.
20. Air vents are operating freely.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.

B. Furnish all instruments required for testing, adjusting, and balancing operations.

1. Verify all instruments have been calibrated.
2. Furnish instruments as recommended by the manufacturer for the TAB application.
3. Furnish instruments that are best suited to the function being measured.
4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.

D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.

E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

F. Determine best locations in main and branch ductwork for most accurate duct traverses.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.

B. Air Outlets and Inlets: Balance branch ducts and terminal devices to within plus or minus 10 percent of design airflow.

3.5 RECORDING AND ADJUSTING

A. Record data regarding design conditions from contract documents and installed conditions from shop drawings including equipment identification number, model number, location, area served, manufacturer, model number, serial number, motor nameplate horsepower and rpm, fan rpm, capacity and electrical voltage, amps and phases.

B. For all systems measure and record the ambient conditions at the time of testing and balancing. Include the following:

1. Dry bulb temperature.
2. Relative humidity.
3. Cloud cover.
4. Wind speed.
5. Time.

C. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

D. Ensure recorded data represents actual measured or observed conditions.

E. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

F. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

H. Cut insulation around ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

I. Patch and seal insulation, vapor barrier, ductwork, and housings, using materials identical to those removed.

J. Seal ducts and piping and test and repair leaks.

K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

L. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

M. Check and adjust systems approximately six months after final acceptance and submit report.

N. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive values are obtained.

O. Take all readings at eye level of the indicated value to prevent parallax.

P. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

Q. Take measurements in the system where best suited for the task.

R. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.6 PRE-TESTING, ADJUSTMENT, AND BALANCING OF EXISTING AIR SYSTEMS

A. Perform preconstruction inspection and testing of existing systems as noted on the plans. Submit test report to engineer for approval. Construction on or demolition of the pre-tested systems shall not proceed until the engineer has reviewed and approved the preconstruction test report.

B. TAB Contractor:

1. Measure and record the operating speed, airflow, and total and external static pressure of each fan system. Provide individual pressure drop readings across all coils, filter banks, dampers and other internal fan system components
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. For variable air volume systems: Open automatic air dampers to full design position to simulate a design day. Measure and record the operating speed and airflow of each fan system for full load conditions.
8. Report on the results of the measurements taken and any deficiencies.

C. Mechanical Contractor:

1. Check the refrigerant charge.
2. Report on the operating condition of the equipment and any deficiencies.

3.7 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Check filters for cleanliness.

B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.

C. Verify volume dampers are installed at locations needed for balancing the air systems.

D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

E. Determine best locations in main and branch ductwork for most accurate duct traverses.

F. Place outlet dampers in the full open position.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

H. Lubricate all motors and bearings.

I. Check fan belt tension.

J. Check fan rotation.

K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.

L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

M. Measure air quantities at air inlets and outlets.

N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

O. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices such as dampers and splitters.

P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

R. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

T. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

U. Where modulating dampers are provided, take measurements and balance at design conditions. Balance variable volume systems at design air flow rate and at minimum air flow rate.

V. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship to maintain building pressure setpoint.

W. Multi-Zone units with Mixing Dampers: Check for motorized damper leakage. Adjust air quantities with mixing dampers set first at design cooling, then at design heating.

X. For variable air volume boxes, set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

Y. On fan powered VAV boxes, adjust air flow switches for proper operation.

Z. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:

1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.
2. Operate supply fan at design speed and measure the outdoor airflow.
3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.

4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.
5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.
6. Repeat this procedure to determine damper position for absolute minimum ventilation.

3.8 DOMESTIC WATER SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Before balancing the system perform these steps:

1. Open valves to full open position.
2. Examine plumbing system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices and balancing valves and fittings are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
3. Remove and clean all strainers.
4. Check pump rotation.
5. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
6. Lubricate all motors and bearings.

END OF SECTION 230593

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SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Mechanical insulation required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Types of Mechanical insulation specified in this Section include the following:

1. Piping Systems Insulation:

   a. Fiberglass
   b. Flexible Elastomeric

2. Ductwork System Insulation:

   a. Fiberglass
   b. Flexible Elastomeric

3. Equipment Insulation:

   a. Fiberglass
   b. Flexible Elastomeric

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields and pipe saddles for protecting insulation vapor barrier and materials and methods for piping installations.
2. Division 23 Section “Underground Hydronic and Steam Piping,” for insulation of piping installed below grade.
3. Division 23 Section “Metal Ducts” for duct liner insulation.

1.2 DEFINITIONS

A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.

B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

B. 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.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E 84 (NFPA 255) method.

1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.
3. Exception: Polyisocyanurate insulation that is not installed in a return air plenum may have a flame spread index of 25 and smoke developed index of 450.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.

C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

D. Manufacturer’s Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer’s identification, product density, and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.6 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS AND MATERIALS

2.1 PIPING INSULATION MATERIALS

A. Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a. CertainTeed Corp.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.

a. K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.
b. Minimum Service Temperature: 0 degrees F
c. Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.
d. Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.

3. Factory Applied Jacket: ASTM C1136, Type I.

a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.
b. Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.
c. Color: White.

B. Flexible Elastomeric:

1. Manufacturers:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.

a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
b. Minimum Service Temperature: Minus 297 degrees F
c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.

3. Factory Applied Jacket:

a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Piping Jacket Schedule in Part 3 of this specification for application of this jacket.

C. Field-Applied Jacket:

1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

2. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.

a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
b. Manufacturers:

1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
3) Or approved equal.

3. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in) Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco
< 12	0.020	0.016	Stucco
≤ 24	0.024	0.016	Stucco
≤ 36	0.032	0.020	See Note 1
> 36	0.040	0.024	See Note 1

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

a. Banding:

1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

4. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

a. Water Vapor Transmission: 0.0 perms per ASTM E96.
b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.

5. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulated duct and piping applications. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

a. Water Vapor Transmission: 0.0 perms per ASTM E96.
b. Puncture Resistance: Minimum 15 pounds per ASTM D1000.

D. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.

E. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.
3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02

Ducts (40 F to ambient)	1.0	0.03

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
5. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.

F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

H. High Density Insulation Billets:

1. Flexible elastomeric: ASTM C534, Type 1.

2.2 EXTERNAL DUCTWORK INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a. CertainTeed Corp.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Insulation: ASTM C553, Type I or II, flexible mineral fiber blanket.

a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
b. Minimum Service Temperature: Minus 20 degrees F
c. Maximum Service Temperature: 450 degrees.
d. Density:

1) 1.5 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch stapling tab.
b. Polypropylene Scrim Kraft (PSK): Kraft paper with glass fiber yarn and bonded to metalized polypropylene, water vapor permeance of 0.02 perms and 2 inch stapling tab.

B. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a. Johns Manville.
b. Knauf Insulation.
c. Owens Corning.

2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.

a. K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.
b. Minimum Service Temperature: 0 degrees F
c. Maximum Service Temperature: 450 degrees.
d. Density:

1) 3.0 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
b. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.
c. Polypropylene Scrim Polyester (PSP): Polyester paper with glass fiber yarn and bonded to polypropylene, water vapor permeance of 0.02 perms.
d. Color: White.

C. Flexible Elastomeric:

1. Manufacturers:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

2. Insulation: ASTM C534, Grade 1, flexible elastomeric cellular rubber insulation, sheet form.

a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
b. Minimum Service Temperature: Minus 40 degrees F
c. Maximum Service Temperature: 180 degrees F.

3. Factory Applied Jacket:

a. Flexible Metal Cladding: Metallic factory-laminated cladding, 17.5 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.00 perms. Provide ArmaTuff or equal. Reference Duct Jacket Schedule in Part 3 of this specification for application of this jacket.

D. Field-Applied Jacket:

1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
2. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.

a. Thickness: 0.032 inch sheet.
b. Finish: Smooth or Stucco. Reference Part 3 for jacket applications.
c. Joining: Longitudinal slip joints and 2 inch laps.
d. Fittings: 0.032 inch thick die shaped fitting covers with factory attached protective liner.
e. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.

3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

a. Water Vapor Transmission: 0.0 perms per ASTM E96.
b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.

4. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulation. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

E. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and other appurtenances as recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coatings, sealers, mastics, protective finishes, and similar compounds as recommended by insulation manufacturer for applications indicated.

1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.
2. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber-based adhesive.
3. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Fosters 30-80, Childers CP-38, Design Polymerics 3040, or equal.
4. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
5. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

2.3 EQUIPMENT INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a. CertainTeed Corp.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Insulation: ASTM C553, Type I and II or ASTM C547 Type II, flexible mineral fiber blanket.

a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
b. Minimum Service Temperature: Minus 20 degrees F
c. Maximum Service Temperature: 450 degrees F for ASTM C553 Types I and II, 1200 degrees F for ASTM C547 Type II.
d. Density: Minimum 1.5 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch lap.
b. Color: White.

B. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

a. Johns Manville.
b. Knauf Insulation.
c. Owens Corning.

2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.

a. K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.
b. Minimum Service Temperature: 0 degrees F
c. Maximum Service Temperature: 450 degrees.
d. Density: Minimum 3.0 pounds per cubic foot.

3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
b. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.
c. Color: White.

C. Flexible Elastomeric:

1. Manufacturers:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

2. Insulation: ASTM C534, Grade I or II, flexible elastomeric cellular rubber insulation, sheet form.

a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
b. Minimum Service Temperature: Minus 40 degrees F
c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.

D. Field-Applied Jacket:

1. Canvas: UL listed, minimum 8 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
2. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.

a. Thickness: 0.032 inch sheet.
b. Finish: Smooth.
c. Joining: Longitudinal slip joints and 2 inch laps.
d. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.

3. Stainless Steel: ASTM A666, Type 304 stainless steel.

a. Thickness: 0.010 inch sheet.
b. Finish: Smooth.
c. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

4. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

a. Water Vapor Transmission: 0.0 perms per ASTM E96.
b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.

5. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulation. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

E. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, and other appurtenances as recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coating, sealers, mastics, and protective finishes as recommended by insulation manufacturer for applications indicated.

1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.
2. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Foster 30-80, Childers CP-38, Design Polymerics 3040, or equal.
3. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36. Childers CP-50AHV2 or equal.
4. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 PROTECTION AND REPLACEMENT

A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.

B. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.

C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.3 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

3.4 PIPING SYSTEM INSULATION INSTALLATION

A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Exposed Piping: Locate insulation and cover seams in least visible locations.

E. Cold Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide vapor barrier jacket according to the Piping Jacket Schedule.
3. Provide high density insulation material under supports or pre-insulated supports.
4. Protect insulation with shields to prevent puncture or other damage. Refer to Section “Hangers & Supports for HVAC Piping & Equipment” for pre-insulated supports and insulation shields.
5. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
6. Secure all-service jacket with self-sealing longitudinal laps.
7. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

F. Hot Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide jackets with or without vapor barrier according to the Piping Jacket Schedule.
3. Secure all-service jacket with self-sealing longitudinal laps.
4. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation of Fittings, Valves, Strainers, Flanges, and Unions:

1. Insulate fittings, joints, and valves with molded insulation of like material, vapor barrier coating, and thickness as adjacent pipe. Provide pre-formed insulation pieces, segmented insulation, or sectional pipe insulation for the application. Provide the same insulation jacket as adjoining pipe.
2. Sectional pipe insulation: Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Hold sectional cuts in place with tie wire or bands. Wire and bands shall be compatible with insulation and jacket.
3. Segmented pipe insulation: Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.
4. Butt each insulation piece tightly against adjoining piece of insulation. Bond pieces together according to Cold Pipe or Hot Pipe installation instructions.

5. Insulate valves up to and including the bonnets, valve stuffing-box studs, bolts, and nuts with a removeable insulation cover. Sectional valve insulation covers shall divide the section along the vertical center line of the valve body.
6. 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.
7. Insulate flanges and unions with a removeable insulation cover. Sectional pipe insulation covers shall divide the section along the center line of pipe.
8. When removeable covers are made from sectional block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, around the insulated device with tie wire. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
9. 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. PVC fitting covers with end caps are also acceptable. Tape PVC covers to adjoining insulation facing using PVC tape.
10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. 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.

I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Maintain vapor barrier through the penetration.

J. Exterior Piping and Piping Exposed to Weather:

1. General: Provide piping jacket around insulation as scheduled in the Piping Jacket Schedule. Jacket material shall be approved by the jacket manufacturer for use with the specific insulation material that it covers. Locate longitudinal seams of outer shell (aluminum, flexible elastomeric, or cladding as applicable) at bottom of pipe. Provide insulation shields so that the piping supports cannot puncture, cut or break the jacket.
2. Paintable Coating: After adhesive has fully cured, apply two coats of insulation manufacturer’s recommended protective coating.
3. Polymeric Coating: Provide insulation shields so that the piping supports do not puncture, cut or break the jacket.
4. Rigid aluminum shell: Space attachment bands 12 inches on center and directly centered over end joints.
5. Multilayer Laminate Vapor Barrier Cladding: Install cladding only when ambient temperature is above 50 degrees F. Provide low-temp products for installation in low ambient temperatures down to 10 degrees F.
6. Rubberized Asphalt Vapor Barrier Cladding: Install cladding for use in ambient temperatures as low as minus 10 degrees F.

K. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.5 PIPING SYSTEM INSULATION SCHEDULE

A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.

B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.

C. Omit insulation on the following:

1. Hot piping within radiation enclosures or unit cabinets.
2. Cold piping within unit cabinets provided piping is located over drain pan.
3. Heating piping between coil and shutoff valves provided piping is located within heated space and not more than three feet from coil.
4. Condensate piping between steam trap and union.
5. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.

D. Exterior Piping: Insulate all exterior HVAC piping with one of the following:

1. Cellular glass.
2. Flexible elastomeric, use high temperature formula for systems with operating temperatures above 220 F. (not acceptable for steam, steam condensate or hot water piping systems with temperatures above 300 F).

E. Variable Refrigerant Flow (VRF) Piping:

1. Service:

a. All refrigerant piping in cooling only, heat pump, or heat recovery VRF systems.

2. Acceptable Insulation:

a. Flexible elastomeric.

F. Sub-Zero Piping (Below 0 degrees F) (-18 degrees C)):

1. Service:

a. Low temperature refrigerant piping.

2. Acceptable Insulation:

a. Flexible elastomeric.

G. Sub-Freezing Piping (0 to 39 degrees F (-18 to 4 degrees C)):

1. Service:

a. Refrigerant liquid lines between the expansion valve and the evaporator coil.
b. Refrigerant suction lines between evaporator coil and compressor.

2. Acceptable Insulation:

a. Mineral fiber.
b. Flexible elastomeric.

H. Cold Piping (40 degrees F (4.4 degrees C) to 60 degrees F):

1. Service:

a. Chilled water supply and return piping.
b. Domestic make-up water piping between the backflow preventer and HVAC system connection.
c. Air conditioner condensate drain piping.
d. Condenser water supply and return piping when used for free cooling.
e. Water-source heat pump supply and return water piping.

2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Mineral fiber.
b. Flexible elastomeric.

I. Warm Temperature Piping (105 degrees to 140 degrees F (40 to 94 degrees C)):

1. Service:

a. Heating hot water supply and return piping.
b. Refrigerant hot gas lines between the compressor and condensing unit.
c. Refrigerant liquid lines between the condensing unit and expansion valve.

2. Insulate each piping system specified above with one of the following types of insulation.

a. Mineral fiber.
b. Flexible elastomeric.

J. Hot Non-Steam Piping (141 to 200 degrees F (61 to 94 degrees C)):

1. Service:

a. Heating hot water supply and return piping.
b. Heated fuel piping.
c. Hot gas refrigerant piping.

2. Acceptable Insulation:

a. Mineral fiber.
b. Flexible elastomeric .

K. Hot Non-Steam Piping (201 F to 250 degrees F (95 to 121 degrees C)):

1. Service:

a. Heating hot water supply and return piping.
b. Heated fuel piping.
c. Hot gas refrigerant piping.

2. Acceptable Insulation:

a. Mineral fiber.
b. Flexible elastomeric (high temp formula 300F).

3.6 PIPE INSULATION THICKNESS SCHEDULE

A. IECC – 2018 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	Nominal Pipe or Tube Size (in.) <1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

a. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: T = r[(1 + t/r)^(K/k) – 1] where

   1) T = minimum insulation thickness (in.),
   2) r = actual outside radius of pipe (in.),
   3) t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
   4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and
   5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
d. For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”
e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

B. IECC – 2015 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	Nominal Pipe or Tube Size (in.) <1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				

>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

a. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: T = r{(1 + t/r)^(K/k) – 1} where

   1) T = minimum insulation thickness (in.),
   2) r = actual outside radius of pipe (in.),
   3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
   4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
   5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
d. For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”
e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

C. IECC – 2012 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
Fluid Operating Temp. Range (°F) And Usage	Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	75	0.5	1.0	1.0	1.0	1.5

Notes:

a. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: T = r{(1 + t/r)^(K/k) – 1} where

    1) T = minimum insulation thickness (in.),
    2) r = actual outside radius of pipe (in.),
    3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
    4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
    5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
d. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

D. IECC – 2009 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid	Insulation Conductivity Conductivity, Btu·in./(hr·ft²·°F)	Nominal Pipe or Tube Size (in.) ≤1-1/2	>1-1/2
Steam	≤0.27	1.5	3.0
Hot Water	≤0.27	1.5	2.0
Chilled Water, brine, or refrigerant	≤0.27	1.5	1.5

Notes:

a. For insulation with a thermal conductivity not equal to 0.27 Btu·in./(hr·ft²·°F) at a mean temperature of 75°F, the minimum required pipe thickness is adjusted using the following equation: T = r{(1 + t/r)^(K/k) – 1} where

    1) T = Adjusted insulation thickness (in.),
    2) r = Actual pipe radius (in.),
    3) t = Insulation thickness from applicable cell in table (in),
    4) K = New thermal conductivity at 75°F (Btu·in./hr·ft²·°F); and
    5) k = 0.27 (Btu·in./hr·ft²·°F).

E. IECC – 2006 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Insulation Conductivity	Nominal Pipe or Tube Size (in.)

Fluid	Conductivity (k), Btu·in./(hr·ft²·°F)	≤1-1/2	>1-1/2
Steam	≤0.27	1.5	3.0
Hot Water	≤0.27	1.0	2.0
Chilled Water, brine, or refrigerant	≤0.27	1.0	1.5

B. ASHRAE 90.1 – 2016 Requirements, Pipe Insulation

	Minimum Pipe Insulation Thickness						
	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
Fluid Operating Temp. Range (°F) And Usage	Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.22–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: T = r{(1 + t/r)^(K/k) – 1} where

   1) T = minimum insulation thickness (in.),
   2) r = actual outside radius of pipe (in.),
   3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
   4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
   5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.

c. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote a) but not to a thickness less than 1 inch.

d. For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”

e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

F. ASHRAE 90.1 – 2013 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	Nominal Pipe or Tube Size (in.) <1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.22–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: T = r{(1 + t/r)^(K/k) – 1} where

   1) T = minimum insulation thickness (in.),
   2) r = actual outside radius of pipe (in.),
   3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
   4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
   5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
c. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote a) but not to a thickness less than 1 inch.
d. For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”
e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

G. ASHRAE 90.1 – 2007 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	Nominal Pipe or Tube Size (in.) <1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				

>350°F	0.32–0.34	250	2.5	3.0	3.0	4.0	4.0
251°F–350°F	0.29–0.32	200	1.5	2.5	3.0	3.0	3.0
201°F–250°F	0.27–0.30	150	1.5	1.5	2.0	2.0	2.0
141°F–200°F	0.25–0.29	125	1.0	1.0	1.0	1.5	1.5
105°F–140°F	0.22–0.28	100	0.5	0.5	1.0	1.0	1.0
40°F–60°F	0.22–0.28	100	0.5	0.5	1.0	1.0	1.0
<40°F	0.22–0.28	100	0.5	1.0	1.0	1.0	1.5

Notes:

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: T = r{(1 + t/r)^(K/k) – 1} where

1) T = minimum insulation thickness (in.),
2) r = actual outside radius of pipe (in.),
3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
c. For piping that shall be installed below grade, reference Division 23 section “Underground Hydronic and Steam Piping.”
d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

H. California Building Efficiency Standards (Title 24 – Part 6) Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
Fluid Operating Temp. Range (°F) And Usage	Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.22–0.28	100	1.0	1.5	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	1.0	1.5	1.5	1.5	1.5

Notes:

a. For insulation outside the stated conductivity range for the applicable fluid temperature range, the minimum thickness (T) shall be determined as follows: T = r[(1 + t/r)^(K/k) – 1] where

1) T = minimum insulation thickness (in.),
2) r = actual outside radius of pipe (in.),
3) t = insulation thickness listed in this table for applicable fluid temperature and pipe size,
4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F), determined in accordance with ASTM C335; and
5) k = the lower value of the conductivity range listed in this table for the applicable fluid temperature.

b. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
c. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.7 PIPING JACKET SCHEDULE

A. Exposed piping within mechanical rooms (below 10 feet):

1. Semi-rigid PVC.
2. Rigid aluminum shell.

B. Exposed piping within mechanical rooms (above 10 feet):

1. Canvas.
2. Semi-rigid PVC.
3. Rigid aluminum shell.

C. Exposed piping:

1. All-service jacket.
2. Canvas.
3. Semi-rigid PVC.

D. Piping within return air plenums:

1. All-service jacket.
2. Canvas.

E. Exterior piping and piping exposed to weather:

1. Paintable coating (flexible elastomeric insulation only.)
2. Polymeric Coating (flexible elastomeric insulation only).
3. Semi-rigid PVC for outdoor application(flexible elastomeric insulation on refrigerant piping only).
4. Rigid aluminum shell.
5. Multilayer laminate vapor barrier cladding.
6. Rubberized asphalt vapor barrier cladding.

F. Sub-Zero Piping:

1. Interior Vapor Barrier Membrane between layers of insulation.

G. Sub-Freezing Piping:

1. Interior Vapor Barrier Membrane under metal or PVC jacket.

3.8 DUCTWORK INSULATION SYSTEM INSTALLATION

A. Maintain continuous thermal and vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.

B. Install insulation on duct systems subsequent to painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces.

D. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Install insulation without sag on underside of duct. Where rectangular ducts are 24 inches in width or greater, secure external insulation to the bottom of the duct with mechanical fasteners, spaced on 18 inches on center (maximum). Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Secure insulation to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention. Lift duct off trapeze hangers and insert spacers to avoid insulation compression.

F. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

H. Lined Ductwork: At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.

I. Cold Ducts:

1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
2. Provide vapor barrier jacket according to the Ductwork Jacket Schedule.
3. Seal joints with vapor barrier tape.
4. Continue insulation, including vapor barrier, through walls, sleeves, hangers, and other duct penetrations.
5. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
6. Where cold ducts are installed in mechanical rooms or non-conditioned spaces (excludes return air plenums), prevent condensation from forming on the duct supports by providing one or more of the following:

    a. Install thermal break such as rigid board insulation between the support and duct.
    b. Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12 inches from point of contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4 inch wide coating of vapor barrier mastic.
    c. If a support device similar to Unistrut is used, foam fill or stuff tube.

J. Hot Ducts:

1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
2. Provide jackets with or without vapor barrier according to the Ductwork Jacket Schedule.
3. Secure joints with staples, tape, or wires.
4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

K. Exterior Ductwork and Ductwork Exposed to Weather:

1. Slope ductwork to ensure that water cannot pond anywhere on the duct. Do not vary the insulation thickness to achieve drainage.
2. Jackets shall be approved by the jacket manufacturer for use with the specific insulation material it covers.
3. Locate longitudinal seams of jacket at bottom of duct. Install jacket in strict conformance with cladding manufacturer's instructions.
4. Seal joints with vapor barrier mastic and reinforcing mesh as recommended by manufacturer or protective jacket as specified.
5. Install aluminum jacket with three metal jacket bands per section.
6. Multilayer Laminate Vapor Barrier Cladding: Install cladding only when ambient temperature is above 50 degrees F. Provide low-temp products for installation in low ambient temperatures down to 10 degrees F.
7. Rubberized Asphalt Vapor Barrier Cladding: Install cladding for use in ambient temperatures as low as minus 10 degrees F.
8. Cover seams in flexible metal cladding with ArmaTuff seal tape or equal.

3.9 DUCTWORK SYSTEM INSULATION SCHEDULE

A. Omit insulation on the following:

1. Fibrous glass ductwork (ductboard).
2. Lined ductwork.
3. Ductwork with sound absorbing linings.

B. Prohibited insulation:

1. Polyisocyanurate installed within a return air plenum.

C. Outdoor Air:

1. Service:

a. Interior untreated outdoor air intake ducts.
b. Pre-conditioned outdoor air ducts.
c. Combustion air intake ducts.

2. Acceptable Insulation:

a. Flexible mineral fiber.
b. Rigid mineral fiber.
c. Flexible elastomeric.

D. Supply Air:

1. Service:

    a. Supply ducts from air handling equipment.

2. Acceptable Insulation:

    a. Flexible mineral fiber.
    b. Rigid mineral fiber.
    c. Flexible elastomeric.

E. Return Air:

1. Service:

    a. Interior ductwork within 10 feet of exterior roof or wall penetrations.

2. Acceptable Insulation:

    a. Flexible mineral fiber.
    b. Rigid mineral fiber.
    c. Flexible elastomeric.

F. Exhaust Air.

1. Service:

    a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
    b. Interior ductwork exhausting from unconditioned spaces (such as loading docks, garages, etc.).
    c. Downstream of heat recovery device (wheel, plate, heat pipe, etc.) to exterior discharge outlet.

2. Acceptable Insulation:

    a. Flexible mineral fiber.
    b. Rigid mineral fiber.
    c. Flexible elastomeric.

G. Relief Air.

1. Service:

    a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
    b. Downstream of heat recovery device (wheel, plate, heat pipe, etc.) to exterior discharge outlet.

2. Acceptable Insulation:

    a. Flexible mineral fiber.
    b. Rigid mineral fiber.
    c. Flexible elastomeric.

H. HVAC plenums and unit housings not pre-insulated at factory or lined.

1. Acceptable Insulation:

a. Flexible mineral fiber.
b. Rigid mineral fiber.
c. Flexible elastomeric.

I. Exterior Ductwork:

1. Service:

a. Supply ductwork.
b. Return ductwork.
c. Exhaust ductwork.
d. Pre-conditioned outside air downstream of conditioning unit.
e. Plenums and unit housings not pre-insulated at factory or lined.

2. Acceptable Insulation:

a. Rigid mineral fiber.
b. Flexible elastomeric.

3.10 DUCT SYSTEM INSULATION THICKNESS SCHEDULE

A. Flexible Mineral Fiber:

1. Interior Ductwork:

a. 0.75 pounds per cubic foot density:

1) 1-1/2 inch thick, minimum R-4.2.

b. 1.5 pounds per cubic foot density:

1) 1-1/2 inch thick, minimum R-4.2.

2. Meet R-value installed at maximum 25% compression, application limited to concealed locations.

B. Rigid Mineral Fiber:

1. Interior Ductwork:

a. 1.5 pounds per cubic foot density:

1) 1 inch thick, minimum R-4.2.

b. 3 pounds per cubic foot density:

1) 1 inch thick, minimum R-4.2.

c. 6 pounds per cubic foot density:

1) 1 inch thick, minimum R-4.2.

2. Ductwork installed in machine, fan, and mechanical equipment rooms:

a. 2 inch thick, minimum R-8.0.

3. Exterior Ductwork or Ductwork Exposed to Weather, or Ductwork:

    a. 3 inch thick, minimum R-12.0.

4. Ductwork in an Unconditioned Space:

    a. 1-1/2 inch thick, minimum R-6.0.

C. Flexible Elastomeric:

1. Interior Ductwork:

    a. 1 inch thick, minimum R-4.2.

2. Exterior Ductwork or Ductwork Exposed to Weather:

    a. Two layers of 1-1/2 inch thick, minimum R-12.0.

3. Ductwork in an Unconditioned Space:

    a. 1-1/2 inch thick, minimum R-6.0.

3.11 DUCTWORK JACKET SCHEDULE

A. Omit jacket on internally lined ductwork.

B. Exposed ductwork within mechanical rooms (below 10 feet):

1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).
6. Canvas.
7. Aluminum with smooth finish.

C. Exposed ductwork within mechanical rooms (above 10 feet):

1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).
6. Canvas.

D. Exposed ductwork:

1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).
6. Canvas.
7. Aluminum with smooth finish.

E. Ductwork within return air plenums:

1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).
6. Canvas.

F. Ductwork in an unconditioned space:

1. Foil Scrim Kraft (FSK).
2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).
6. Canvas.

G. Exterior ductwork and ductwork exposed to weather:

1. Flexible Metal Cladding (flexible elastomeric only).
2. Aluminum with stucco finish.
3. Multilayer Laminate Vapor Barrier Cladding.
4. Rubberized Asphalt Vapor Barrier Cladding.

3.12 EQUIPMENT INSULATION INSTALLATION

A. Install insulation subsequent to painting, testing, and acceptance of tests.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Protect insulation to prevent puncture and other damage.

D. Exposed Equipment: Locate insulation and cover seams in least visible locations.

E. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

F. Do not apply insulation to equipment, breechings, or stacks while hot.

G. Do not insulate flanges and unions of equipment carrying fluids less than 105 degrees F.

H. Provide neatly beveled edge at interruptions of insulation.

I. Fasten insulation to equipment with studs, pins, clips, adhesives, wires, or bands.

J. Stagger insulation joints for both single and double layer application, where feasible. Apply each layer of insulation separately. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.

K. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped

edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

L. Cover insulated surfaces with jacketing, factory or field applied, neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.

M. Cold Equipment:

1. Insulate entire system, including flanges and unions. Maintain continuous vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.
2. Provide vapor barrier jacket, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.
3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

N. Hot Equipment:

1. Insulate entire system, including flanges and unions.
2. Provide jacket, with or without vapor barrier, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.

O. Exterior Equipment and Equipment Exposed to Weather:

1. Jackets shall be approved by the jacket manufacturer for use with the specific insulation material it covers.
2. Seal joints with vapor barrier mastic and reinforcing mesh as recommended by manufacturer or protective jacket as specified.
3. Install aluminum or stainless steel jacket with three metal jacket bands per section.
4. Multilayer Laminate Vapor Barrier Cladding: Install cladding only when ambient temperature is above 50 degrees F. Provide low-temp products for installation in low ambient temperatures down to 10 degrees F.
5. Rubberized Asphalt Vapor Barrier Cladding: Install cladding for use in ambient temperatures as low as minus 10 degrees F.

3.13 EQUIPMENT INSULATION SCHEDULE

A. Omit Insulation on the following:

1. Boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplates.
2. Factory pre-insulated equipment.

B. Do not apply insulation to equipment that operates outside of the minimum and maximum service temperature range.

C. Provide flexible removable and reusable blanket insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

D. Cold Equipment:

1. Service:

a. Refrigeration equipment, including chillers, tanks and pumps.
b. Cold surfaces not factory insulated.
c. Drip pans under chilled equipment.

d. Chilled water storage tanks.
e. Chilled water buffer tank.
f. Chilled water expansion tanks, air separators and piping accessories.
g. Chilled water pumps.
h. Equipment exposed to freezing with heat tracing.

2. Acceptable Insulation:

a. Flexible Mineral Fiber:

1) 2 inch thick for cold surfaces above 35 degrees F.
2) 3 inch thick for surfaces 35 degrees F and lower.

b. Rigid Mineral Fiber:

1) 2 inch thick for cold surfaces above 35 degrees F.
2) 3 inch thick for surfaces 35 degrees F and lower.

c. Flexible Elastomeric:

1) 3 inch thick for surfaces above 35 degrees F.
2) 4 inch thick for surfaces 35 degrees F and lower.

E. Hot Equipment:

1. Service:

a. Boilers.
b. Hot water storage tanks.
c. Hot water buffer tanks.
d. Heat exchangers.
e. Hot water expansion tanks, air separators, and piping accessories.
f. Hot water pumps.
g. Boiler feedwater storage tanks.
h. Deaerators.
i. Flash tanks.
j. Fuel oil heaters.

2. Acceptable Insulation:

a. Flexible Mineral Fiber:

1) 3 inch thick for steam boilers and steam-jacketed heat exchangers.
2) 2 inch thick for all other applications.

b. Rigid Mineral Fiber:

1) 3 inch thick for steam boilers and steam-jacketed heat exchangers.
2) 2 inch thick for all other applications.

c. Flexible Elastomeric:

1) 2 inch thick for hot water equipment operating at or below 180 F.
2) 3 inch thick for equipment operating between 180 and 275 F.

F. Coils

1. Application Requirements: Insulate the following coils that are installed in cold ducts:

   a. Hydronic coils.
   b. Refrigerant coils.
   c. Duct mounted electric heaters (do not insulate the control panel of the heater).

2. Acceptable Insulation:

   a. For ducts with exterior wrap, apply the same insulation as installed on the duct.
   b. For ducts with interior duct liner, apply one of the following:

      1) Flexible Mineral Fiber: 1-1/2” thick, minimum R4.2.
      2) Rigid Mineral Fiber: 1” thick, minimum R-4.2.
      3) Flexible Elastomeric: 1” thick, minimum R-4.2.

G. Breechings, Chimneys, and Stacks:

1. Service:

   a. Breechings between heating equipment outlet and stack or chimney connection, except for double wall or factory insulated breechings.
   b. Stack from bottom to top except for factory insulated stacks.

2. Acceptable Insulation:

   a. Flexible Mineral Fiber: 2 inch thick.

3.14 EQUIPMENT JACKET SCHEDULE

A. Omit jacketing on equipment pre-insulated and jacketed from the factory.

B. Interior Equipment (all except flexible elastomeric insulation):

1. Canvas.
2. Aluminum.
3. Stainless steel.

C. Equipment in unconditioned spaces (all except flexible elastomeric insulation):

1. Canvas.
2. Aluminum.
3. Stainless steel.

D. Exterior Equipment or Equipment Exposed to Weather:

1. Aluminum.
2. Stainless Steel.
3. Multilayer Laminate Vapor Barrier Cladding.
4. Rubberized Asphalt Vapor Barrier Cladding.

E. Exterior Generator Exhaust or Generator Exhaust Exposed to Weather:

1. Aluminum.

2. Stainless Steel.

END OF SECTION 230700

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SECTION 230800 - COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY

A. See Section 019113 - General Commissioning Requirements for Contractor's commissioning responsibilities and Commissioning Scope of Work, including a list of systems to be commissioned. Comply with requirements of Section 019113.

B. The Commissioning Authority (3PCx) directs and coordinates all commissioning activities as described in Section 019113.

1.02 RELATED REQUIREMENTS

A. Section 019113 - General Commissioning Requirements.

B. Section 230593 - Testing, Adjusting, and Balancing for HVAC.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

5.01 TESTING, ADJUSTING AND BALANCING (TAB) REPORT

A. Coordinate with TAB contractor to provide final TAB report to Commissioning Authority upon completion. Commissioning Authority will review TAB report prior to functional testing.

5.02 OPERATION AND MAINTENANCE MANUALS

A. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

B. See Section 017800 for additional requirements.

END OF SECTION

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SPECIFICATIONS NOMENCLATURE

A. Acronyms used in this specification are as follows:

FMCS	Facility Management and Control System
SI	Systems Integrator
ES	Enterprise System
SCP	Stand Alone Control Panel
DDCS	Direct Digital Control System
BMS	Building Management System
NAC	Network Area Controller
IDC or BC	Interoperable Digital Controller/Building Controller
ASC	Application Specific Controller
PCU	Programmable Control Unit
GUI	Graphical User Interface
HMI	Human Machine Interface (Wall/Panel mounted display)
WBI	Web Browser Interface
POT	Portable Operator's Terminal
PMI	Power Measurement Interface
DDC	Direct Digital Controls
LAN	Local Area Network
WAN	Wide Area Network
OOT	Object Oriented Technology
PICS	Product Interoperability Compliance Statement
BIBB	BACnet Interoperability Building Blocks
RH	Relative Humidity

1.2 RELATED SECTIONS

A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

B. The following sections constitute related work:

1. Section 23 0000 - HVAC General
2. Section 25 1300 – Integrated Automation System (IAS)

C. The following divisions constitute related work:

1. Division 01 – General Requirements
2. Division 23 – Heating, Ventilating and Air Conditioning
3. Division 25 – Integrated Automation System
4. Division 26 – Electrical
5. Division 28 – Electronic Safety and Security

1.3 OVERVIEW

A. Client has standardized on ASHRAE Standard 135-2010, BACnet/IP and BACnet MS/TP Control System architecture as the preferred communication method for the BMS. The division of work for this project is segmented between Division 23 (Controls) and Division 25 (Systems Integration). Divisions 23 and 25 shall be supported by a preselected Controls Contractor and Systems Integrator (SI). The SI is responsible for coordinating the consistency of the local operator workstation system graphics, providing Network Area Controllers (NACs), global logic and sequences. The Division 23 Controls Contractor and Division 25 Systems Integrator shall be CBRE|ESI.

B. The General Contractor of this project shall directly hire CBRE|ESI.

1. Contact:

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C. The purpose of this specification's BMS architecture is to provide an open, common, easily expandable, non-proprietary and enterprise level front end/user interface that is maintained through a single global logic platform and provider to insure uniformed application, implementation and user experience throughout Client's portfolio of buildings, as well as a process that adheres to Client's standards and requirements while taking advantage of local representation for the majority of the field device applications and ongoing service for those devices.

The Division 25 SI shall provide NAC panels, global logic sequences, GUI, schedules and alarming. The Division 25 contractor shall provide field devices and controllers supporting application specific real time control logic. The Division 25 SI and Division 23 contractor shall work together in constructing a final BMS architecture that meets the full intent and requirements of this specification.

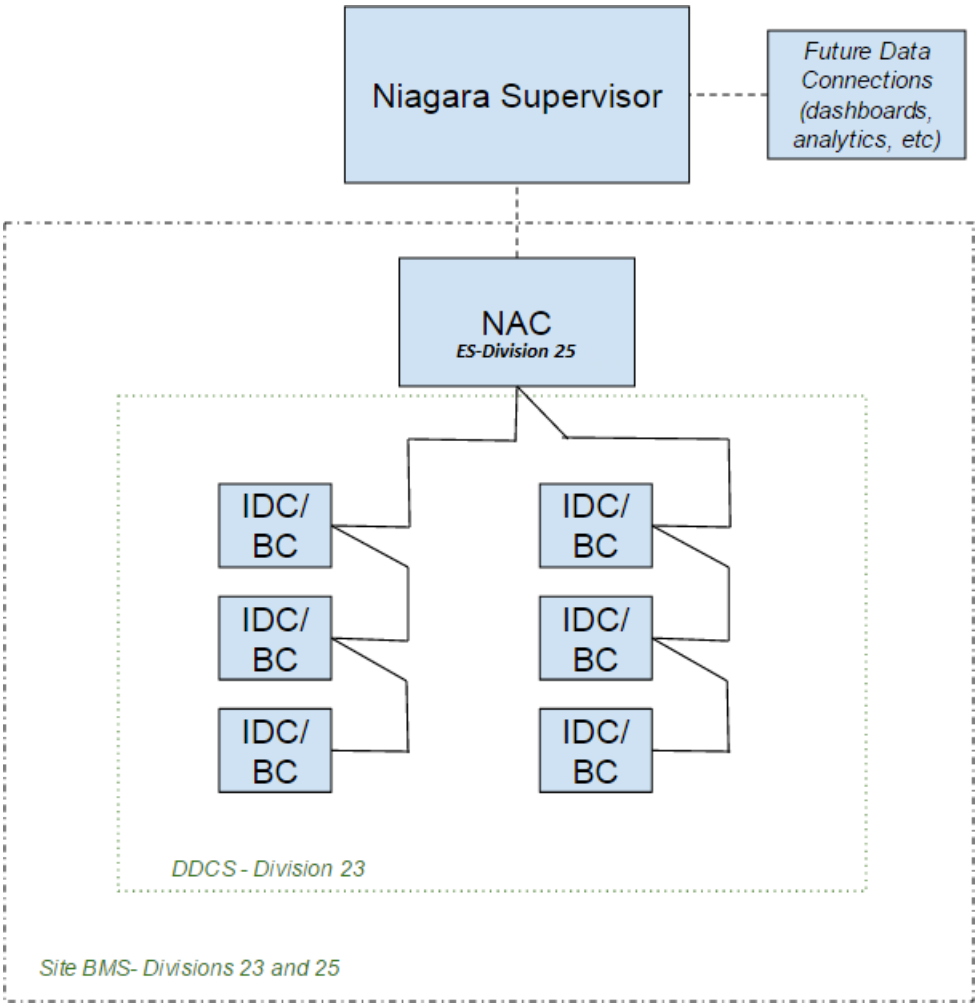
The Division 25 SI shall be responsible for testing the final control logic for the BMS. The Division 23 Controls contractor shall implement and test all control logic as it pertains to that portion of work associated with those devices, services and deliverables included in this specification.

D. General: The local Building Management System (BMS) system shall be a BACnet protocol system capable of integrating unit DDC controllers within a web-based network interface. The system interface will depict each mechanical system and building floor plan by a point-and-click graphic. An existing centralized SQL server shall gather the data from the site.

E. Client will operate an Enterprise level management system provided through a Niagara N4 platform. The Enterprise System (ES) will be Niagara N4. The local Building Management System (BMS) shall be Niagara N4 and, must be compatible with the ES without additional hardware or software expense. Controllers shall be supplier agnostic, however must be open platform to facilitate any vendor to maintain/modify. Specific compatibility requirements are detailed within Division 23 09 93.

F. System Architecture: As aforementioned the Client Enterprise System will be implemented through the Niagara N4 architecture. The unit DDC controllers as depicted below, broken out by 'dashed lines', will be open bid and sourced from the approved supplier list, have BACnet interface, and capable of integrating seamlessly into the Niagara N4 platform.

1. The Client enterprise systems, enterprise programming, and local BMS mapping ALL to be implemented via the Niagara N4 architecture.
2. BMS connected devices and HVAC DDC interface to be provided via specified and approved supplier list below.



G. The entire Direct Digital Control System (DDCS) shall be comprised of a network of interoperable, stand-alone, fully programmable digital controllers (IDC) communicating via BACnet/IP or BACnet MS/TP protocol (provided under Division 23 Controls) to Network Area Controllers (NACs) (provided under Division 25).

1. Interoperable Digital Controllers (IDC) shall be:

   a. Distech – BACnet/IP
   b. Easy I/O FG-Series – BACnet/IP
   c. Distech – BACnet MS/TP

2. NACs provided under Division 25 shall be based on the Niagara N4 Framework-Vykon Brand

H. The DDCS shall include all Ethernet network, BACnet MS/TP trunk wiring or other wiring, as necessary, to create a control network that shall connect all field controllers, field devices, NAC's, routers, switches and other network devices as may be indicated on the riser diagram.

I. Although BACnet/IP and BACnet MS/TP are the preferred communication protocol between field controllers and NACs it is acknowledged that not all factory provided controls may support a BACnet/IP or BACnet MS/TP option. In the event factory mounted controls/solutions are not capable of BACnet/IP or BACnet MS/TP the following communication protocols are acceptable in the following order of preference and only with prior written approval; Modbus TCP/IP, Modbus Async (RTU).

J. Factory mounted controls:

1. Where factory controls are provided and support BACnet/IP, BACnet MS/TP, Modbus TCP/IP or Modbus RTU communication methods the controls shall be connected directly to a Division 25 provided NAC communication port. Division 25 shall provide all communication wiring (BACnet MS/TP and Modbus RTU), all other wiring shall be provided and installed by the Division 23 (Mechanical) contractor. The wiring, wiring installation and termination for this connection shall be provided by the Division 23 (Mechanical) contractor. Where the device is considered to be associated with a critical process and the device supports I/O the Division 23 contractor shall also hard wire the appropriate I/O to an IDC.
2. The following control options will be allowed for factory RTU equipment:

    a. Carrier: RTU Open, BACnet MSTP
    b. Lennox: Prodigy, BACnet MSTP
    c. Trane: ReliaTel, BACnet MSTP

3. The BACnet RTU controller shall expose at a minimum the following points and provide the required read and or read/write access:

Point Description	Read	Read/Write	Note
Active Alarm Code(s)	X		*List of Possible Alarms*
Active Setpoint	X		
Cooling Enable (Command or Setpoint)		X	*Provide Range of Values*
Cooling Stage(s) Status	X		
Discharge Air Temperature	X		
Economizer Enable (Command or Setpoint)		X	*Provide Range of Values*
Heating Enable (Command or Setpoint)		X	*Provide Range of Values*
Heating Stage(s) Status	X		
Minimum Outside Damper Position		X	*Provide Range of Values*
Occupancy Command		X	
Occupied Cooling Setpoint		X	*Provide Range of Values*
Occupied Heating Setpoint		X	*Provide Range of Values*
Outside Air Temperature		X	
Outside Damper Position	X		
Power Exhaust Fan(s) Status	X		
Return Temperature	X		
Supply Fan Command	X		
Supply Fan Speed	X		
Supply Fan Status	X		
Unit Alarm Status	X		
Unit Operating Mode	X		*List of Possible Modes*
Unoccupied Cooling Setpoint		X	*Provide Range of Values*
Unoccupied Heating Setpoint		X	*Provide Range of Values*
Zone Temperature	X		

4. Where factory controls are provided with outputs/inputs only or communication protocols other than BACnet/IP, BACnet MS/TP, Modbus TCP/IP or Modbus RTU, the Division 23 contractor shall interface those points necessary to accurately monitor and control the system(s) through connections to an interface provided by the Division 23 Controls contractor. The Division 23 Controls contractor shall provide and expose the associated points to the Division 25 SI via BACnet/IP or BACnet MS/TP. Where the device is considered to be a critical process and the device supports I/O the Division 23 Mechanical contractor shall also hard wire the appropriate I/O to the IDC.

K. The Division 23 (Controls and Mechanical) contractor shall also provide connections to other devices/sub systems that may not be directly part of the HVAC system as identified in the bid documents.

1. The gas and water meters are furnished or installed under this division of work and require integration to the BMS under this section.
2. The fire alarm/FACP interface, power meters, air compressor interface, and generator interface are furnished under another division of work but require integration to the BMS under this section.
3. These systems include but are not be limited to:

System	Communication Method	Points for integration to BMS	Interface (provided by)
Fire Alarm - FACP	Hard-wired IO	Alarm, Supervisory, Trouble	Relay board (Div 26)
Power Meter(s) Note: Sub-meters located at each MSB.	Modbus TCP	kW, kWh, PF, V, A, Quality	EGX Gateway (Div 26)
Gas Meter(s)	Hard-wired IT	Flow, Consumption	n/a (Div 23 - Controls)
Water Meter(s)	Hard-wired IT	Flow, Consumption	n/a (Div 23 - Controls)
Air Compressors	Modbus TCP or BACnet IP	Status, Alarms	Gateway (Div 23 - Mechanical)
Generator	Modbus TCP or BACnet IP	Status, Alarms	Gateway (Div 26)
Lighting Control Panels – coordinate with Div 26	Hard-wired IO	occupied, unoccupied	Relay board (Div 26)
HVLS fans	Modbus TCP or BACnet IP	status (on/off/rotation direction/speed), alarm	n/a (Div 23 – Controls)
Battery Charging Area Hydrogen Sensors	Modbus TCP or BACnet IP	status, alarm	n/a (Div 23 – Controls)
UPS @ MDF room	Modbus TCP or BACnet IP	status, alarm	n/a (Div 23 – Controls)
MDF controls	Modbus TCP or BACnet IP	status, temperature, humidity,alarms	n/a (Div 23 – Controls)

4. These systems are provided with a BACnet IP, BACnet MS/TP, Modbus TCP/IP, Modbus RTU, Lon Talk or other communication method, and the device shall be connected directly to a NAC communication port (provided by Division 25 SI). The wiring installation and termination for this connection shall be provided by the Division 23 Mechanical contractor.
5. Division 23 contractor shall provide sufficient wiring and IDC(s) for those points necessary to accurately monitor and/or control the system(s) as indicated on the plans and/or in the points matrix, through connections to a NAC (provided by the Division 25 SI).

L. It is the owner's expressed goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner

shall receive ownership of all job specific configuration documentation, data files, and application- level software developed for the project, software shall have the appropriate licensing to allow the software to function fully with respect to its use for this project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner. The owner shall determine which organizations to be named in the SI organization ID ("orgid") of all software licenses. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier.

M. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

N. The system shall provide protection against excessive demand situations during startup periods by automatically introducing time delays between successive start commands to heavy electrical loads.

O. Upon the resumption of power, each SCP 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.

P. System shall have the ability to ramp open or closed any output to allow for non-instantaneous operation of a device.

Q. History files shall not be programmed to reside on the IDC. All histories shall be recorded and stored at the network level (NACs).

R. All control components such as controllers, communication modules, switches, servers, LAN connectors, etc. shall be mounted in cabinets. Cabinets shall be single door UL 508A enclosures with hinged doors. All cabinets shall be provided with locksets that match.

S. No critical processes such as chiller plants, pump plants, cooling towers or central fan stations shall require network communication for either normal, redundant or emergency operation. Any use of network communications for operation of interrelated mechanical equipment shall be identified in original shop drawings and shall not be built until approved.

T. All RS485 communication trunk wiring topology shall be constructed in such a manner that controls from differing manufacturers do not communicate/reside on the same trunk; unless authorized by the Division 25 SI.

U. The Division 23 Controls contractor shall provide a list of network requirements for the project to include but not limited to: quantity of ports and IP addresses, software ports, etc. to Client with the bid submittal and project submittal package.

V. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP protocol or dedicated communication network using the BACnet MS/TP protocol.

1. The use of BACnet Ethernet is prohibited.

PART 2 - MATERIALS

2.1

2.1 GENERAL

A. The Direct Digital Control System (DDCS) shall be comprised of a network of interoperable, stand-alone digital controllers and other devices as specified herein.

B. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of thiscontract.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

A. The intent of this specification is to provide a fully networked, distributed control system based on the BACnet communication protocols. It is the intent of this specification to provide a system that is comprised of all BACnet communicating devices. All IDC's, whether of the ASC or PCU type, shall be of one manufacturer. Systems based on IDC's from multiple manufacturers shall not be permitted (are not acceptable - without prior written approval).

2.3 CONTROL SYSTEM HARDWARE

A. BACnet CONTROLLERS – GENERAL REQUIREMENTS

1. Controls shall be microprocessor based Interoperable BACnet Controllers in accordance with the ANSI/ASHRAE Standard 135-2010. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The DDCS contractor must provide a PICS document showing the installed systems compliance level to the ANSI/ASHRAE Standard 135-1995. The BACnet application shall conform to, at a minimum, compliance Level 3; with the ability to support data read and write functionality.
2. The IDCs shall communicate with the NAC via BACnet/IP at a baud rate of not less than 10 Mbps, or an MS/TP connection at a baud rate of not less than 38.4 kb (78.6 kbpreferred).
3. BACnet devices must be supplied using the IP or MS/TP communications method. The preferred BACnet MS/TP wire jacket color is orange however any color that is unique and distinguishable from all other communication wiring at the facility is acceptable.
4. Where applicable, control shall be accomplished through BTL based devices where the application has a BACnet BIBB defined. Where BTL devices are not available for a particular application, such as some freely programmable controllers, the DDCS Contractor must provide complete product technical documentation including a complete listing of BACnet devices, BACnet objects, object types and object instances. This information shall be provided to the Division 25 System Integrator. The manufacturer's published BACnet PICS and BIBB statements shall be provided to the Division 25 SI for each controller defining the programming or setup of each device. The DDCS Contractor shall provide all programming and documentation necessary to set up and configure the supplied devices per the specified sequences of operation.
5. The DDCS Contractor shall route BACnet MS/TP network trunks to the Network Area Controller (NAC) as indicated. Coordinate locations of the NAC with the Division 25 System Integrator and Contractor to ensure that maximum network wiring distances, as specified by the BACnet wiring guidelines, are not exceeded. A maximum of 35 devices may occupy any one BACnet MS/TP trunk.
6. BACnet addresses on each trunk shall be sequential and non-conflicting starting at 2.
7. The Division 23 Controls contractor shall be responsible for assigning BACnet addresses.

8. The Network Area Controller (NAC), supplied by the Division 25 System Integrator, shall provide all scheduling, alarming, trending, and network management for the BACnet-based devices.

B. Modbus CONTROLLERS – GENERAL REQUIREMENTS

1. Controls shall be microprocessor based Interoperable Modbus RTU or TCP/IP controllers in accordance with Modbus-IDA standards. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensorsignals.
2. The use of Modbus RTU to TCP/IP conversion modules, drivers or gateways shall include a manufacturer's statement of operability.
3. All data must be available and/or mirrored within the Modbus 4x or "Holding Register" memory area. The other areas can be optionally supported, but all 0x, 1x, and 3x data must be readable in the 4x memory area. For digital writes, support of single-bit writes (function 5) to the 0x area are acceptable. Products that require access to the 1x and 3x area to operate are not acceptable; access to 1x/3x area must be optional.
4. Register 4x00001 must exist and be readable to allow simple, predictable "comm tests.
5. Software tools must be configurable to limit reads and write to user selectable limits; the software must accept being limited to reading 1 register per transaction and writing 1 register per transaction.
6. Software tools must allow setting to the Modbus/TCP "Unit Id" to a value other than zero. This is required for Ethernet-to-Serial bridging.

2.4 INTEROPERABLE DIGITAL CONTROLLERS (IDC)

A. IDC controllers shall be microprocessor based interoperable controllers.

B. The IDC category of controllers includes ASCs and PCUs devices.

C. Provide IDC's and ancillary devices as herein specified, as indicated on the drawings, and as necessary to perform the sequences of operation. The following equipment to be controlled shall include but not be limited to:

1. Rooftop packaged air conditioners
2. Gas-fired space heaters/Make-up Air Units
3. Exhaust Fans for ventilation and pressurization control
4. Louvers with motorized dampers
5. Additional equipment outlined herein or on the Mechanical and Electrical Drawings.

D. The complete IDC, including accessory devices such as relay, transducers, power supplies, etc., shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.

E. The IDC shall provide LED indication of communication and controller performance to the technician, without cover removal.

F. All IDCs shall be fully application programmable and shall at all times maintain their certification, if so certified. All control sequences within or programmed into the IDC shall be stored in nonvolatile memory, which is not dependent upon the presence of a battery, to be retained.

G. The DDCS Contractor supplying the IDC's shall provide, at a minimum, the following documentation for each device dependent on communication protocol:

1. BACnet: Network configuration parameters name and type (AI, AO, AV, MV, BI, BO, BV), BACnet Object Type, Object Instance, Object Name and Object Description

2. Modbus: Modbus register list, scale factors and offsets.

H. It is the responsibility of the DDCS Contractor to ensure that the proper BACnet objects are provided in each IDC and are exposed for connection to them by the Division 25 System Integrator, as required. Use of manufacturer-specific BACnet objects shall not be permitted, unless software is provided to allow the use of them by any third-party network management tool (prior written approval required).

I. The DDCS Contractor supplying the IDCs shall (in addition to the above) provide graphical printouts of all/each IDC programming in PDF or PNG formats. Printouts shall include clear indication of how all input and output network variables interact with the controller process.

J. The DDCS Contractor shall provide two copies of the IDC programming tool and configuration tool, with documentation, to the owner.

1. This tool shall allow the owner to fully program, configure, diagnose and otherwise manage the controller, without limitations.
2. The tool shall be of the latest revision currently in production release by the manufacturer.
3. The tool shall be licensed to the owner and shall not require annual license renewal fees.

K. Each IDC shall execute all application programs, calculations and commands via an integrated IO/32-bit minimum microcomputer resident in the panel. All data base for each panel and the operating system and all application programs for each panel shall be stored within the panel. The microcomputer shall permit floating point calculations to enable the performance of energy calculations. Each IDC shall contain a real-time clock to enable the panel to automatically perform time-based functions.

L. Each IDC shall be capable of full operation either as a completely independent panel or as part of the building wide control system. All panels shall contain the necessary equipment for direct interface to the sensors and actuators connected to it. The SCP network shall be able to detect changes in any IDC panel point status and report this change to the NAC.

M. Failure of any IDC on the system shall not affect the proper operation of the remaining system components.

N. Surge transient protection shall be provided for each IDC for the purpose of suppressing induced voltage transients.

O. In the event of a power outage or controller reset, each IDC shall enter a preprogrammed state on power re-application. Upon application of power to the IDC, all control conditions will start from an ‘off’ / ‘closed’ position or the default state. This state will be maintained for an automatically adjusted amount of time. Once this time delay has passed, the IDC control sequence shall resume according to current values.

P. All IDC’s shall be provided with a communications port to allow connection of any industry standard laptop PC and custom configuration tool. Program access via this communications port allows direct field modification of the configuration parameters.

Q. Each IDC shall be listed under UL 916 (Energy Management Systems) and shall be tested to comply with sub-part J of Part 15 FCC rules for Class A computing equipment.

R. Each IDC shall incorporate into its planning enough physical and logic accommodation for an increase of 20% future growth. In addition, all processes shall allow for point expansion to this increase during vendor startup should the need arise. Spare point capacity shall be provided for each I/O point type (AI, BI, AO, BO) proportional to their I/O point totals per SCP.

S. Each IDC shall accept digital (ON/OFF) and analog (temperature, valve position, etc.) feedback so that building equipment operation can be verified.

2.5 APPLICATION SPECIFIC CONTROLLER (ASC)

A. Each terminal unit shall have an Application Specific Controller (ASC) designed to provide the specified sequences. The controller shall store all specific control sequences and program settings in nonvolatile memory.

B. ASCs shall be microprocessor based interoperable controllers. All Interoperable Digital Controllers shall bear the applicable interoperability logo on each product delivered if so certified.

C. Each ASC shall perform all intended temperature control functions in a 'standalone' mode should the unit incur a loss of communications.

D. The complete ASC including accessory devices such as relay, transducers, power supplies, etc., shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.

E. All ASC's shall be provided as self-sufficient units to maximize reliability and shall include internal 'soft' clock, operating systems, communication timing and interrupt controls, and shall be suitable for the specified applications.

F. Digital Inputs

1. All digital inputs shall be over voltage protected.
2. Digital input types supported by the CU:

    a. Normally open contacts (24V and 120V).
    b. Normally closed contacts (24V and 120V).
    c. Current/no current.
    d. Voltage/no voltage.
    e. Pulse/Totalizer contacts.

G. Digital Outputs

1. All digital outputs shall be 24-volt AC, current sinking, 0.5 amp opto-isolated triacs.
2. Digital outputs shall be capable of handling maintained as well as pulsed outputs for momentary or magnetic latching circuits. It shall be possible to configure outputs for 3-mode control (fast-slow-off) and 2-mode control.

H. Analog Inputs

1. All analog inputs shall be over voltage protected.
2. The analog to digital resolutions shall be a minimum of 10 bit.
3. Analog inputs shall accept the following temperature types: 10K Ohm thermistor, 20K Ohm thermistor, or 1K Ohm RTD.
4. Inputs shall be configurable to accept a wide range of inputs including: 4-20mA, 1-5Vdc, 2- 10Vdc, etc.

I. Analog Outputs

1. The ASC shall accommodate true analog outputs. Voltage (0-10V) and current (4-20 mA) outputs shall be accommodated.
2. All analog outputs shall be proportional current or voltage type.

3. The digital to analog resolution shall be a minimum of 10 bit.
4. Outputs shall be configurable so that 0-100% output commands can represent any portion of the output voltage/current range.
5. Outputs shall be reversible so that an increasing output command yields a decreasing electrical signal.

J. The following modes of control shall be incorporated into each ASC:

1. Occupied shall be a mode designed for normal occupied control of an area during regular business hours. This mode shall have unique heating and cooling set points associated with it.
2. Unoccupied shall be a mode designed for after-hours control of an area. This mode shall have unique heating and cooling set points associated with it.
3. Override shall be a mode designed to invoke normal occupied control during after-hours of an area. This mode shall use the occupied heating and cooling set points.
4. Economy shall be a mode designed for normal occupied times when energy demand usage is high and control set points need to be adjusted for lower energy use. This mode shall have unique heating and cooling set points associated with it.
5. Morning Warm-Up on units with an outdoor air economizer shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied set points but it will prevent outdoor air from entering the space. The outdoor air will move to its minimum position once the morning warm-up mode is over and the occupied mode is activated.
6. Morning Warm-Up on VAV units shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied set points but it will prevent the VAV box from maintaining a minimum air flow until the morning warm-up mode is over and the occupied mode is activated.
7. VAV box ASC's shall have an integral damper actuator and shall be the manufacturer's standard VAV box controller.
8. It shall be the responsibility of the Division 23 Mechanical contractor to verify that VAV box controllers will physically fit into the VAV box controls enclosure, and that the controllers can register the expected minimum and maximum flow rates utilizing the flow probe provided by the VAV box manufacturer.

    a. Acceptable Manufacturers

        1) Distech – BACnet/IP
        2) Easy I/O FG-Series – BACnet/IP
        3) Distech – BACnet MS/TP

2.6 PROGRAMMABLE CONTROL UNITS (PCU'S)

A. A BACnet™ based DDC Programmable Control Unit (PCU) shall be provided where required to perform the sequence of operation. The PCU shall be fully programmable by the programming tool. The controller shall be store all specific control sequences and program settings in non- volatile memory.

B. PCU controllers shall be microprocessor based interoperable controllers. All Interoperable Digital Controllers shall bear the applicable interoperability logo on each product delivered if so certified.

C. Each PCU shall perform all intended temperature control functions in a 'standalone' mode should the unit incur a loss of communications.

D. The complete PCU including accessory devices such as relay, transducers, power supplies, etc., shall be factory-mounted, wired and housed in a NEMA 1 enclosure or as required by the location and local code requirements.

E. All PCU's shall be provided as self-sufficient units to maximize reliability and shall include internal 'soft' clock, operating systems, communication timing and interrupt controls, and shall be suitable for the specified applications.

F. In the event of a power outage or controller reset, each PCU shall enter a preprogrammed state on power re-application. Upon application of power to the PCU, all control conditions will start from an 'off' / 'closed' position or the default state. This state will be maintained for an automatically adjusted amount of time. Once this time delay has passed, the PCU control sequence shall resume according to current values

G. All PCU's shall be provided with a communications port to allow connection of any industry standard laptop PC and custom configuration tools. Program access via this communications port allows direct field modification of the configuration parameters.

H. Digital Inputs

1. All digital inputs shall be over voltage protected.
2. Digital input types supported by the CU:

    a. Normally open contacts (24V and 120V).
    b. Normally closed contacts (24V and 120V).
    c. Current/no current.
    d. Voltage/no voltage.
    e. Pulse/Totalizer contacts.

I. Digital Outputs

1. All digital outputs shall be 24-volt AC, current sinking, 0.5 amp opto-isolated triacs.
2. Digital outputs shall be capable of handling maintained as well as pulsed outputs for momentary or magnetic latching circuits. It shall be possible to configure outputs for 3-mode control (fast-slow-off) and 2-mode control.

J. Analog Inputs

1. All analog inputs shall be over voltage protected.
2. The analog to digital resolutions shall be a minimum of 10 bit.
3. Analog inputs shall accept the following temperature types: 10K Ohm thermistor, 20K Ohm thermistor, or 1K Ohm RTD.
4. Inputs shall be configurable to accept a wide range of inputs including: 4-20mA, 1-5Vdc, 2- 10Vdc, etc.

K. Analog Outputs

1. The PCU shall accommodate true analog outputs. Voltage (0-10V) and current (4-20 mA) outputs shall be accommodated.
2. All analog outputs shall be proportional current or voltage type.
3. The digital to analog resolution shall be a minimum of 10 bit.
4. Outputs shall be configurable so that 0-100% output commands can represent any portion of the output voltage/current range.
5. Outputs shall be reversible so that an increasing output command yields a decreasing electrical signal.

L. PCU Control Modes

The following modes of control shall be incorporated into each PCU:

1. Occupied shall be a mode designed for normal occupied control of an area during regular business hours. This mode shall have unique heating and cooling set points associated with it.
2. Unoccupied shall be a mode designed for after-hours control of an area. This mode shall have unique heating and cooling set points associated with it.
3. Override shall be a mode designed to invoke normal occupied control during after-hours of an area. This mode shall use the occupied heating and cooling set points.
4. Economy shall be a mode designed for normal occupied times when energy demand usage is high and control set points need to be adjusted for lower energy use. This mode shall have unique heating and cooling set points associated with it.
5. Morning Warm-Up on units with an outdoor air economizer shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied set points but it will prevent outdoor air from entering the space. The outdoor air will move to its minimum position once the morning warm-up mode is over and the occupied mode is activated.
6. Morning Warm-Up on VAV units shall be a mode designed for the pre-heat/pre-cool time before normal occupancy occurs. This mode shall allow heating or cooling as required by the occupied set points but it will prevent the VAV box from maintaining a minimum air-flow until the morning warm-up mode is over and the occupied mode is activated.

M. Acceptable Manufacturers

1. Distech – BACnet/IP
2. Easy I/O FG-Series– BACnet/IP
3. Distech – BACnet MS/TP

2.7 SOFTWARE LICENSE AGREEMENT

A. The Owner shall sign or accept a copy of the IDC and NAC manufacturer's standard software and firmware licensing agreements as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

2.8 MATERIAL QUALITY ASSURANCE

A. The manufacturer of the IDC and NAC digital controllers shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the digital controller manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar.

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.

2.9 STAND ALONE CONTROL PANELS (SCP)

A. Furnish control panels of code gauge steel with locking doors for mounting all devices as shown. Panels shall conform to NEMA 1 standards, unless otherwise indicated.

B. Control panels shall meet all requirements of UL508A and shall be so certified and supporting documents provided.

C. Panels shall be constructed prior to delivery to site.

D. For each SCP provide a panel size sufficient for 20% growth of the I/O located within a specific SCP as it pertains to Division 23 Controls delivered I/O.

E. All external wiring shall be connected to terminal strips mounted within the panel.

1. Under no circumstances will field wiring be terminated from inputs or outputs direct to the I/O on the controllers. Further, all spare points meeting the 20% requirement will be pre- wired to terminal strips.

F. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels and the identification number of the panel.

G. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

H. Each panel shall have a pin-hinged door and master keyed lock.

I. Maximum panel depth no more than 9 inches.

J. Each panel shall be capable of proper operation in an ambient environment of 32 to 122 degrees F and 10% to 90% relative humidity

K. Each control panel (SCP) shall be provided with a minimum of one network switch (4 or 5 port) with one port available for local access to entire system from a service laptop if the control device(s) located in the SCP communicate over an IP network.

1. Managed switches, switches larger than five ports or switches utilized for other resources other than those associated with the BMS shall be provided by others.
2. Switches housed in SCPs supporting NACs or other Division 23 Controls provided BAS supporting devices shall be provided by the Division 23 contractor.

L. Each switch provided by the Division 23 Controls contractor shall terminate on a dedicated port on a building wide LAN/WAN switch provided by others. SCP housed switches shall not be cascaded or daisy chained.

PART 3 - DIVISION OF WORK

3.1 OVERVIEW

A. The Division 23 Controls/DDCS Contractor shall be responsible for all field controllers (IDC: ASC, PCU) - when not provided by packaged/factory controls - control devices, sensing devices, control panels, controller programming, and controller programming software.

B. The Division 23 (Mechanical) Contractor shall be responsible for all controller input/output wiring, power wiring (120VAC and other), interlock and safety wiring, controller network wiring, Ethernet LAN wiring as it pertains to NAC drops or other BMS attached devices, controller I/O wiring, wiring between non-HVAC sub systems and the BMS, all terminations, installation of BACnet MS/TP communication or other communication wiring to the NACs, installation of all control panels (including the Division 25 control panels), installation of all control devices, installation of all wiring as well as commissioning and point to point checkout as it pertains to components/systems identified under Division 23. The Division 23 Controls Contractor shall provide stand-alone controls for the MDF room. The controls shall control the MDF rooftop units, humidifier, de-

humidifier, isolation dampers, exhaust fan, and monitor all related sensors as described in the sequences and mechanical drawings. A HMI shall be provided to allow for local operation of the MDF room controls including setpoint adjustment and lead/lag unit selection. The provided controls for the MDF room shall be monitored by the BMS via BACnet IP or BACnet MS/TP.

C. The Division 25 System Integrator (SI) shall be responsible for the Network Area Controller(s) (NAC), NAC control panels, providing communication (BACnet MS/TP and/or Modbus RTU) cable, providing Ethernet patch cables, software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, set up of schedules, trend logs and alarms, network management, global supervisory control applications, system integration, coordination of the NAC to the local or wide area network as well as commissioning and point to point check as it pertains to deliverables identified under Division 25. The SI will also be responsible for overseeing point to point check out of the Division 23 deliverables in coordination with and support of the Division 23 contractor to include but not limited to the GUI and global control applications.

D. Divisions 23, 25 & Client Responsibility Table

Items/Task	Div 23 (Mech)	Div 23 (Control)	Div 25	Tenant
Network Area Controllers/Panels (SCP)			X	
Interoperable Digital Controllers/Panels (SCP)			X	
Installation of IDC & NAC panels	O	X		
Sensors and Control Devices		X		
Installation of Sensors and Control Devices	X			
Application specific controller programming (IDCs)		X		
Global logic/NAC programming			X	
IDC/NAC Integration		O	X	
Factory supplied controller configuration		X	O	
Factory supplied controller integration			X	
Graphics			X	
IDC, NAC, field device terminations/connections	X			
MDF Room temperature and humidity control with HMI	O	X		
IP Addresses				X
Server and switch gear hardware specifications				X
Server hardware procurement				X
Switch gear (>5port or managed) hardware procurement				X
Switch gear (4-5 port, located within Div 23 – SCPs)		X		
Switch gear (4-5 port, located within Div 25 – SCPs)			X	
Electrical wiring (120VAC and other)	X			
Ethernet wiring (controller/device) drops	X			
Ethernet (LAN/WAN) & infrastructure				X
BACnet IP and Modbus TCP/IP wiring	X			
BACnet MS/TP trunk wiring (IDCs, NACs, factory controls)	X			
Modbus RTU trunk wiring (IDCs, NACs, factory controls)	X			
LonTalk trunk wiring (IDCs, NACs, factory controls)	X			

Sub-system wire drops and termination to BAS	X		O	
Workstations & Monitors				X
Operator system training		O	X	O
Complete point to point checkout of IDCs		X		
Complete point to point checkout of factory provided controls		O	X	
Overall system verification		O	X	O
X = Responsible O = Participate				

E. Work by Others

1. The demarcation of work and responsibilities between the Division 23 Contractor and other related trades shall be as outlined in the BMS Responsibility Matrix.
2. BMS Responsibility Matrix (below):

WORK	**FURNISH**	**INSTALL**	**Low Volt. WIRING (24VDC or less)**	**LINE POWER (120V or greater)**
BAS low voltage wiring	23	23	23	N/A
BAS communication wiring (BACnet MS/TP or Modbus)	25	23	23	N/A
BAS conduits and raceway	23	23	23	26
Automatic dampers	23	23	N/A	N/A
Manual valves	23	23	N/A	N/A
Automatic valves	23	23	23	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations.	23	23	23	26
BAS Current Switches	23*	23	23	N/A
BAS Control Relays	23*	23	23	N/A
Power distribution system monitoring interfaces	26	26	23	26
IDCs, equipment, housings, enclosures and panels	23/25	23	23	26
NACs and panels (Requires dedicated 120V circuit)	25	23	23	26
Smoke Detectors	26	26	26	26
Fire/Smoke Dampers	23	23	23	26
Fire Dampers	23	23	N/A	N/A
Duct Detector	26	23	26	26
VFDs	23	26	23	26
Fire Alarm shutdown relay interlock wiring	26	26	26	26
Fire Alarm smoke control relay interlock wiring	26	26	23	26
Fireman's Smoke Control Override Panel	26	26	26	26
Fan Coil Unit controls	23	23	23	26
Packaged RTU space mounted controls	23	23	23	26
Packaged RTU factory-mounted controls	23	23	23	26
Packaged RTU field-mounted controls	23	23	23	26
Starters, HOA switches, Starter heaters	26	26	N/A	26
Control damper actuators	23*	23	23	26
Generator Modbus	26	26	23	26
Lighting Relay Panels	26	26	23	26
Divisions: 23 – HVAC (23* - Controls) 25 – Integrated Automated System 26 – Electrical				

F. Documentation required by Division 23

1. The DDCS Contractor shall provide catalog data sheets, wiring diagrams and point lists to the Division 25 MSI for proper coordination of work. The points list shall be in spreadsheet format (Microsoft Excel) and include the following:

   a. BACnet Points: point/object name as used by the system, the object/point type; i.e. analog, binary, input, output, etc., the point/object description; i.e., what it is, and the data structure type; i.e. Boolean, integer, floating point, etc. The manufacturer's published BACnet PICS and BIBB statements shall be provided to the Division 25 System Integrator for each controller defining the programming or setup of each device. The DDCS Contractor shall provide all programming and documentation necessary to set up and configure the supplied devices per the specified sequences of operation.

      1) For each BACnet device, provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet or MS/TP.

   b. Modbus Points: point/object name as used by the system, point object description, node address/register for each point including scaling or offset information for each point. The DDCS Contractor shall provide all programming and documentation necessary to set up and configure the supplied devices per the specified sequences of operation.

2. A Client standard naming/tagging convention shall be utilized for this project. A copy of the standard naming convention shall be provided prior to the start of the project and shall be utilized by the Division 23 contractor.
3. Network requirements as it pertains to LAN/WAN switch ports, static IP addresses, software ports and any other network items provided by others but required for a properly functioning BMS.
4. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.
5. Provide the Division 25 integrator a copy of all design documents and submittals in electronic format – AutoCAD™ version 2007 or later or Visio™ version 2003 or later, Microsoft Word and Microsoft Excel files.
6. Points list provided to the Division 25 SI. See last section of this specification.

PART 4 - IMPLEMENTATION REQUIREMENTS

4.1 OVERVIEW

A. The local BMS shall directly control HVAC equipment as specified in Section 23 09 93 - Sequence of Operations for HVAC Controls.

B. The local BMS shall provide monitoring of CO2 levels at selected locations for use in conjunction with temperature/RH sensors to calculate the heat index. CO2 sensor coverage is based generally on square footage; guidelines for placement are as follows.

1. One minimum of one sensor shall be provided for each zone of major occupancy or per air handling device
2. If a number of devices serve a large zone (warehouse space), sensors are to be spaced to provide a maximum coverage of 65,000 sq. ft. If occupancy density/patterns/usage is different in two adjacent areas, each area shall be considered a separate zone.

3. Where Demand Controlled Ventilation (DCV) is scheduled, CO2 levels shall be monitored at all times, with RTU control based on the highest CO2 level or occupancy zone, not average.
4. Ventilation in the office space shall be maintained per Code.

C. The local BMS shall provide combination temperature/humidity sensors, installed in the Warehouse areas as shown on the Mechanical drawings and/or spaced on approximately 300 foot centers (45,000 s.f. coverage). Sensors shall be placed 1 per 300ft and have system interface to all points for monitoring purposes including all graphics, programming, trending, alarms, and commissioning. No control strategy is provided; provide web interface to all points for monitoring purposes including all graphics, programming, trending, alarms, and commissioning, eg Air Rotation Units, Gas fired furnaces.

D. The local BMS shall provide flow monitoring of the domestic water main. Flow meter shall be turbine meter, equal to Elster T4000 or equivalent with pulse/analog converter. Size to be confirmed with water piping design documents. Piping and installation of meter shall be by others. Provide communication wiring, web interface to all points, graphics, programming, trending, alarms, and commissioning.

E. The local BMS shall provide flow monitoring of the natural gas main. Flow meter shall be flanged turbine or ultrasonic meter. Meter size to be confirmed with gas piping design. Piping and installation of meter shall be by others. Provide communication wiring, web interface to all points, graphics, programming, trending, alarms, and commissioning.

F. The local BMS shall use the BACnet protocol for communication to the web server and for communication between control modules. I/O points, schedules, set points, trends, and alarms specified in Section 23 0993 – "Sequence of Operations for HVAC Controls" shall be BACnet objects.

G. The local BMS shall include outdoor weather station to gather OA conditions to be linked into BMS. The weather station shall be positioned remote from the HVAC and exhaust equipment, away from direct reflective surfaces and direct sunlight, which may distort data quality.

H. The local BMS shall include a building static pressure differential sensor to monitor building pressure as it relates to outdoors.

I. The local BMS shall monitor the temperature and relative humidity of all IDF rooms.

J. HVAC Equipment shall include a factory mounted DDC controller capable of communicating through BACnet the I/O points list specified in Section 23 09 93.

4.2 APPROVED CONTROL SYSTEMS

A. Use control system hardware and software that meet the requirements of this specification. Approved manufacturers are: Niagara N4, Distech, Easy I/O FG Series.

4.3 QUALITY ASSURANCE

A. Installer and Manufacturer Qualifications

1. Installer shall have an established working relationship with above OEMs and their respective BMS and DDC Controls to include interface with the Niagara N4 architecture, network solutions. Installer shall be proficient in BACnet system integration.
2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

3. The manufacturer of the IDC and NAC digital controllers shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the digital controller manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar.
4. 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. Final approval of installer shall be by Client Construction Manager.

PART 5 - CODES AND STANDARDS

5.1 OVERVIEW

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:

1. National Electric Code (NEC)
2. International Building Code (IBC)

    a. Section 719 Ducts and Air Transfer Openings
    b. Section 907 Fire Alarm and Detection Systems
    c. Section 909 Smoke Control Systems
    d. Chapter 28 Mechanical

3. International Mechanical Code (IMC)

PART 6 - SYSTEM PERFORMANCE

6.1 OVERVIEW

A. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.

B. Performance. OEM Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.

C. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.

D. Control Stability and Accuracy. Control loops shall be capable of maintaining measured variable set points within tolerances listed in Table 2. (select offset consistent with efficiency controlling building comfort.)

Table 1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5ºC (±1ºF)
Ducted Air	±0.5ºC (±1ºF)
Outside Air	±1.0ºC (±2ºF)
Dew Point	±1.5ºC (±3ºF)
Water Temperature	±0.5ºC (±1ºF)
Delta-T	±0.15ºC (±0.25ºF)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO_2)	±50 ppm

Note 1: Accuracy applies to 10% - 100% of scale
Note 2: For both absolute and differential pressure
Note 3: Not including utility supplied meters

Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0ºC (±2.0ºF)	
Duct Temperature	±1.5ºC (±3ºF)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

6.2 SUBMITTALS

A. Product Submittal Requirements: Meet requirements of Section 01 3000 on Shop Drawings, Product Data, and Samples. Provide six copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2006 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and 3 prints of each drawing on 11" x 17" paper. When manufacturer's cut sheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Provide submittals within 12 weeks of contract award on the following:

B. BMS and Direct Digital Control (DDC) System Hardware

1. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
2. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:

    a. Direct digital controllers (controller panels)
    b. Transducers and transmitters
    c. Sensors (include accuracy data)
    d. Actuators
    e. Valves
    f. Relays and switches
    g. Control panels
    h. Power supplies
    i. Batteries
    j. Operator interface equipment
    k. Wiring

3. Wiring diagrams and layouts for each control panel. Show termination numbers.
4. Floor plan schematic diagrams indicating field sensor and controller locations.
5. Riser diagrams showing control network layout, communication protocol, and wire types.
6. Schematic diagrams of control, communication, and power wiring for central system installation. Show interface wiring to control system.
7. Network riser diagrams of wiring between central control unit and control panels.

C. Controlled Systems

1. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
3. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
4. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
5. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system. List I/O points and software points specified in Section 23 0993. Indicate alarmed and trended points.

D. Description of process, report formats, and checklists to be used in Section 23 0923 Article 3.17 (Control System Demonstration and Acceptance).

E. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

6.3 SCHEDULES

A. Schedule of work provided within one month of contract award, indicating:

1. Intended sequence of work items
2. Start date of each work item
3. Duration of each work item
4. Planned delivery dates for ordered material and equipment and expected lead times

5. Milestones indicating possible restraints on work by other trades or situations

B. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

6.4 PROJECT RECORD DOCUMENTS:

Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

A. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and 6 prints of each drawing on 11" x 17" paper.

B. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 23 0923 Article 3.17 (Control System Demonstration and Acceptance).

C. Operation and Maintenance (O&M) Manual. Printed, electronic, or online help documentation of the following.

1. As-built versions of submittal product data.
2. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
3. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
4. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
5. Documentation of programs created using custom programming language including set points, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, set points, tuning parameters, and objects can be viewed using furnished programming tools.
6. List of recommended spare parts with part numbers and suppliers.
7. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including equipment and sensors.
8. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
9. Licenses, guarantees, and warranty documents for equipment and systems.
10. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

6.5 TRAINING MATERIALS

Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

PART 7 - WARRANTY

7.1 WARRANT WORK AS FOLLOWS:

A. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

B. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

C. If Engineer determines that equipment and systems operate satisfactorily at the end of final start- up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

D. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above- mentioned items. Do not install updates or upgrades without Owner's written authorization.

E. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

PART 8 - OWNERSHIP OF PROPRIETARY MATERIAL

8.1 PROJECT-SPECIFIC SOFTWARE AND DOCUMENTATION SHALL BECOME OWNER'S PROPERTY. THIS INCLUDES, BUT IS NOT LIMITED TO:

A. Graphics

B. Record Drawings

C. Database

D. Application programming code

E. Documentation

PART 9 - COMMUNICATION

9.1 OVERVIEW

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet network. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

B. Install new wiring and network devices as required to provide a complete and workable control network. Use existing Ethernet backbone for network segments marked "existing" on project drawings.

C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

D. Network operator interface and value passing shall be transparent to network architecture.

1. An operator interface connected to a controller shall allow the operator to interface with each network controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each network controller.
2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the network. Program and test all cross- controller links required to execute control strategies specified in Section 23 0993. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the network. If applicable, system shall automatically adjust for daylight saving and standard time.

F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

9.2 CONTROLLER SOFTWARE

A. Building and energy management application software shall reside and operate in the Niagara N4 NAC (provided by the Div 25). Individual unit software shall reside in the factory installed DDC controller as a Product Integrated Controller (PIC).

B. System Security. See Paragraph 2.3.F.5 (Security) and Paragraph 2.3.F.15.c (Operator Activity).

C. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in Section 23 09 93 - Sequence of Operations for HVAC Controls.

D. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, set point, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

E. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

F. Energy Calculations.

1. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

G. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

H. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and set point.

I. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 23 0993 - Sequence of Operations for HVAC Controls.

9.3 CONTROLLERS

A. BACnet Communication.

1. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
2. BACnet routing shall be performed by NACs or other BACnet device routers as necessary to connect BCs to networks of ASCs.
3. Each ASC shall reside on a BACnet network using the MSTP Data Link/Physical layer protocol.

B. Communication.

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

C. Environment. Controller hardware shall be suitable for anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

D. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

E. Serviceability.

1. Controllers shall have diagnostic LEDs for power, communication, and processor.
2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

F. Memory

1. Controller memory shall support operating system, database, and programming requirements.
2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

G. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

H. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

9.4 INPUT AND OUTPUT INTERFACE

A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.

B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two- position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

H. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

9.5 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish overcurrent protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and overcurrent protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

    a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
    b. Line voltage units shall be UL recognized and CSA listed.

9.6 AUXILIARY CONTROL DEVICES

A. Motorized Control Dampers.

1. Type. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.

    a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel- blade and shall direct airstreams toward each other.
    b. Other modulating dampers shall be opposed-blade.
    c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.

2. Frame. Damper frames shall be 2.38 mm (13 gauge) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminum with reinforced corner bracing.
3. Blades. Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance. Blades shall be not less than 1.5875 mm (16 gauge).
4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 L/s·m ^{2} (10 cfm per ft^2) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).
6. Sections. Damper sections shall not exceed 125 cm - 150 cm (48 in. - 60 in.). Each section shall have at least one damper actuator.
7. Linkages. Dampers shall have exposed linkages.

B. Electric Damper and Valve Actuators.

1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
3. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)
4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.

C. Temperature Sensors.

1. Sensors should be integral Temperature/RH sensors (T/H) with a battery life of not less than 10 years.
2. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
3. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m2(10 ft2) of duct cross-section.
4. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
5. Space Sensors. Space sensors shall have set point adjustment, override switch, display, and communication port as shown.
6. Differential Sensors. Provide matched sensors for differential temperature measurement.
7. Duct and room T/H sensors shall have a sensing range of 20%-80%.
8. Duct sensors shall have a sampling chamber.
9. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°C-75°C (40°F-170°F).
10. T/H sensors shall not drift more than 1% of full scale annually.

D. Relays

1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from set point shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

E. Override Timers

1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

F. Current Transmitters

1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full- scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
3. Unit shall be split-core type for clamp-on installation on existing wiring.

G. Current Transformers

1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
2. Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.
3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

H. Voltage Transmitters

1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
2. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400- 600 Vac. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.
3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

I. Voltage Transformers

1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic.

J. Power Monitors

1. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.
2. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

K. Current Switches

1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

L. Pressure Transducers

1. Transducers shall have linear output signal and field-adjustable zero and span.
2. Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.
3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.

M. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

N. Local Control Panels

1. Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub- panel.
2. Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.
3. Each local panel shall have a control power source power switch (on-off) with overcurrent protection.

9.7 WIRING AND RACEWAYS

A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.

B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

9.8 FIBER OPTIC CABLE SYSTEM

A. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra- building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.

B. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

C. CAT5,5e,6 and fiber must be installed by an Client IT approved contractor

PART 10 - EXECUTION

10.1 EXAMINATION

A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough- in work.

B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.

C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 23 0923 work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

10.2 PROTECTION

A. DDCS Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.

B. DDCS Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

10.3 COORDINATION

A. Site:

1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Submittals. See Section 23 0923 Article 1.10 (Submittals).

C. Test and Balance.

1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
2. Train Test and Balance Contractor to use control system interface tools.
3. Provide a qualified technician to assist with testing and balancing the first 20 terminal units.
4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

D. Life Safety

1. Duct smoke detectors required for air handler shutdown are provided under Division 28 (unless noted otherwise on the drawings). Interlock smoke detectors to air handlers for shutdown as specified in Section 23 0993 - Sequence of Operations for HVAC Controls.

E. Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.

1. Communication media and equipment shall be provided as specified in Section 23 0923 Article 2.2 (Communication).
2. Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation described in Section 23 0993 Appendix A regardless of where within the contract documents those products are described.
3. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of thisspecification.
4. Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

10.4 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

10.5 FIELD QUALITY CONTROL

A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 0923 Article 1.8 (Codes and Standards).

B. Continually monitor field installation for code compliance and workmanship quality.

C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

10.6 WIRING

A. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 23 0923 differ from Division 26, Section 23 0923 shall take precedence.

B. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.

C. Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.

D. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.

E. Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.

F. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high- voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.

G. Do not install wiring in raceway containing tubing.

H. Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m (10 ft) intervals.

I. Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.

J. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.

K. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.

L. Include one pull string in each raceway 2.5 cm (1 in.) or larger.

M. Use color-coded conductors throughout.

N. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.

O. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.

P. Adhere to requirements in Division 26 where raceway crosses building expansion joints.

Q. Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.

R. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.

S. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.

T. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

10.7 COMMUNICATION WIRING

A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).

B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

D. Verify entire network's integrity following cable installation using appropriate tests for each cable.

E. Install lightning arrester according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

G. Label communication wiring to indicate origination and destination.

H. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

I. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:

1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
4. An MS/TP EIA-485 network shall have no T connections.

10.8 FIBER OPTIC CABLE

A. During installation do not exceed maximum pulling tensions specified by cable manufacturer. Post-installation residual cable tension shall be within cable manufacturer's specifications.

B. Install cabling and associated components according to manufacturer's' instructions. Do not exceed minimum cable and unjacketed fiber bend radii specified by cable manufacturer.

10.9 INSTALLATION OF SENSORS

A. Install sensors according to manufacturer's recommendations.

B. Mount sensors rigidly and adequately for operating environment. Label/number each sensor so that in the event a sensor is dislodged, it can be located and reinstalled accurately.

C. Install room temperature sensors on concealed junction boxes properly supported by wall framing. For operational purposes, within the warehouse sensors should be mounted seven feet from the ground.

D. The local BMS shall provide monitoring of CO2 levels at selected locations for use in conjunction with temperature/RH sensors to calculate the heat index. CO2 sensor coverage is based generally on square footage; guidelines for placement are as follows.

1. One sensor should be used for each zone of major occupancy or per air handling device
2. If a number of devices serve a large zone (warehouse spaces), sensors shall be spaced to provide a maximum coverage of 65,000 sq. ft. If occupancy density/patterns/usage is different in two adjacent areas, each area should be considered a separate zone.
3. Where Demand Controlled Ventilation (DCV) is scheduled, CO2 levels shall be monitored at all times with RTU control based on the highest CO2 level or occupancy zone, not average.

E. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.

F. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.

G. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 1 ft (0.3 m) of sensing element for each 1 ft2 (0.1m2) of coil area.

H. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat- conducting fluid in thermal wells.

I. Install outdoor air temperature sensors on north wall at designated location with sun shield.

J. Differential Air Static Pressure.

1. Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
3. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high- pressure port to a location behind a thermostat cover.
4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
5. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
6. Mount gauge tees adjacent to air and water differential pressure taps. Install shutoff valves before tee for water gauges.

K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hardwired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switchstatus.

10.10 ACTUATORS

A. General. Mount actuators and adapters according to manufacturer's recommendations.

B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.

1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten linkage.
3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
4. Provide necessary mounting hardware and linkages for actuator installation.

C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.

10.11 WARNING LABELS

A. Affix permanent warning labels to equipment that can be automatically started by the control system.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows.

C A U T I O N

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before Servicing.

B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.
2. Warning labels shall read as follows.

C A U T I O N

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

10.12 IDENTIFICATION OF HARDWARE AND WIRING

A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.

B. Label pneumatic tubing at each end within 5 cm (2 in.) of termination with a descriptive identifier.

C. Permanently label or code each point of field terminal strips to show instrument or item served.

D. Label control panels with minimum 1 cm (½ in.) letters onlaminated plastic nameplates.

E. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.

F. Label room sensors related to terminal boxes or valves with nameplates.

G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

H. Label identifiers shall match record documents.

10.13 PROGRAMMING

A. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Section 23 09 93 (Sequences of Operation). If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix B to Section 23 09 93 may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.

B. Software Programming. Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented. Text-based programs shall be modular, structured, and commented to clearly describe each section of the program.

1. Application Programming. Provide application programming that adheres to sequences of operation specified in Section 23 0993. Program documentation or comment statements shall reflect language used in sequences of operation.
2. System Programming. Provide system programming necessary for systemoperation.

C. CONTROL SYSTEM CHECKOUT AND TESTING

D. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.

1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 23 0923.
2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.
7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
8. Alarms and Interlocks.

a. Check each alarm with an appropriate signal at a value that will trip the alarm.
b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

10.14 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.17 (Control System Checkout and Testing). Provide Client’s designated Mechanical Engineer with log documenting completion of startup tests.

1. Engineer will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.
2. Demonstration shall follow process submitted and approved under Section 23 0923 Article 1.10 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.
3. Demonstrate actual field operation of each sequence of operation as specified in Section 23 0993. Provide at least two persons equipped with two-way communication. Demonstrate

calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.

4. Demonstrate compliance with Section 23 0923 Part 1 (System Performance).
5. Demonstrate compliance with sequences of operation through each operational mode.
6. Demonstrate complete operation of operator interface.
7. Demonstrate each of the following.

    a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a set point change representing an actuator position change of at least 25% of full range. Each sample's trend data shall show set point, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.
    b. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting set point, and status of set points and other affected equipment parameters.
    c. Building fire alarm system interface.
    d. Trend logs for each system. Trend data shall indicate set points, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in Section 23 0993. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 15 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 23 0923 Article 2.3 Paragraph E.11 (Trend Configuration).

8. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

B. Acceptance.

1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 23 0923 Article 1.10 (Submittals).

10.15 CLEANING

A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.

B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.

C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

10.16 TRAINING

A. Training will be jointly performed by the DDCS (Division 23 Controls) and SI (Division 25) contractors. Provide training for a designated staff of Owner's representatives. Training shall be

provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

B. Training shall enable students to accomplish the following objectives.

1. Proficiently operate system
2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate workstation and peripherals
6. Log on and off system
7. Access graphics, point reports, and logs
8. Adjust and change system set points, time schedules, and holiday schedules
9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
10. Understand system drawings and Operation and Maintenance manual
11. Understand job layout and location of control components
12. Access data from DDC controllers
13. Create and change system graphics
14. Create, delete, and modify alarms, including configuring alarm reactions
15. Create, delete, and modify point trend graphs and multi-point trend graphs
16. Configure and run reports
17. Configure and calibrate I/O points
18. Maintain software and prepare backups
19. Interface with job-specific, third-party operator software
20. Add new users and understand password security procedures

C. Divide presentation of objectives into three sessions (1-12, 13-22, and 23-24). Participants will attend one or more of sessions, depending on knowledge level required.

1. Day-to-day Operators (objectives 1-12)
2. Advanced Operators (objectives 1-12 and 13-22)
3. System Managers and Administrators (objectives 1-12 and 23-24)

D. Provide course outline and materials according to Section 23 0923 Article 1.10 (Submittals). Provide one copy of training material per student.

E. Instructors shall be factory-trained and experienced in presenting this material.

F. Perform classroom training using a network of working controllers representative of installed hardware.

PART 11 - POINTS LIST

11.1 SUMMARY

A. A points table (example below) shall be developed by the Division 23 Controls contractor for each system included in this project. The points shall be accessible from the Graphical User Interface (GUI) and/or the Web browser interface (WBI), supplied under Division 25. The supplier of the IDC devices shall ensure that the points listed in this table are accessible on their respective networks, by the Network Area Controller(s) (NAC).

B. All points shall be exposed at the IDC controller level using the BACnet IP or BACnet MSTP protocol and be discoverable by the NAC(s) or server level device. Where points are allowed to be exposed as modifiable they shall be programmed as such.

C. The point lists shall include the point/object name as used by the system, the object/point type; i.e. analog, binary, input, output, etc., the point/object description; i.e., what it is, and the data structure type; i.e. Boolean, integer, floating point, etc.

D. The Division 23 Controls contractor shall construct a separate matrix/table for each system controlled through the DDCS listing each point and point functionality using the abbreviations below.

System:	**Device Address:**							
Point Name	**Point Address**	**Point Description**	**D**	**M**	**A**	**L**	**S**	**GC**
Supply Fan Status	*BI-3*	*Fan current switch*	*x*			*x*		
Occupancy Mode	*BV-40*	*Schedule point*		*x*			*x*	

D = Display only
M = Modify value A = Alarm
L = Log
S = Schedule
GC = Global supervisory control routine (such as demand limiting)

END OF SECTION 230900

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SECTION 230924 - SMALL BUILDING CONTROL SYSTEM

Specifier Note: The use of this section is intended for projects that do not have BAS control.

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. System Description.

B. Thermostat Control Equipment

C. Sensors and Relays

1.2 SUBMITTALS

A. Submit shop drawings of equipment provided for temperature control. Submit operation and maintenance data, including trouble-shooting maintenance guide, step-by-step procedures indexed for each controller and thermostat function, inspection period, cleaning methods and materials, and calibration tolerances.

B. Provide integrated wiring diagrams showing interconnections between field-installed equipment and package wiring furnished with the HVAC equipment. Control wiring shall be sized to accommodate the voltage drop associated with the distance between the control device and the controller.

PART 2 - PRODUCTS AND MATERIALS

2.1 SYSTEM DESCRIPTION

A. Provide a complete temperature control system including control panels, controllers, control power transformers, thermostats, sensors, time switches, override timers, actuators, relays, and wiring as required to control the systems as specified on the drawings.

2.2 THERMOSTAT CONTROL EQUIPMENT

A. Provide thermostat control equipment with sufficient communication, programming, input and output connections, and modulating or staging capability to meet the sequence of operations. Provide thermostats with the features as indicated:

1. LCD or LED display screen.
2. Button or touchscreen interface.
3. Display temperature.
4. Display temperature setpoint.
5. Adjust temperature setpoint.
6. Limit temperature setpoint adjustment within plus or minus 3 degrees F.
7. Display operating mode.
8. Adjust operating mode.
9. Adjust schedule, minimum seven day occupied/unoccupied.
10. Security lockout.
11. Security cover.
12. Insulated backing for exterior wall mounting.

B. At contractor's option where multiple sensors are shown, the sensors may be provided with the thermostat in a single device.

C. Provide programmable thermostats that shall control packaged equipment by the packaged equipment manufacturer or Honeywell, Johnson Controls, Trane, or equal.

D. Provide economizer controllers for equipment specified to include economizer in its sequence of operation but is not factory furnished with economizer controls included. Economizer controller shall be Honeywell YW7220 Jade Economizer module kit or equal. Economizer module kit shall include the economizer logic module, damper actuator, and sensors of type required to implement the type of economizer scheduled on the drawings.

2.3 SENSORS AND RELAYS

A. Manufacturers and model numbers are listed for reference as to quality and features required for the sensors and relays. Provide general-purpose type sensing elements for use in input and output sensors. Provide transmitters or transducers with sensor as required, compatible with the controllers used, with range suitable for the systems encountered. Transmitters and transducers shall have offset and span adjustments, temperature compensation, shock and vibration immunity, and zeroing capability. Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.

B. Provide sensors that meet the following minimum performance:

1. Dry-bulb temperature sensors at a minimum shall be accurate to +/- 2 degrees Fahrenheit over the range of 40 to 80 degrees Fahrenheit.
2. Wet-bulb temperature shall be calculated using dry-bulb temperature and humidity and shall be accurate to +/- 2 degrees Fahrenheit.
3. Enthalpy shall be calculated using dry-bulb temperature and humidity and shall be accurate to +/- 3 BTU/lb over the range of 20 to 36 BTU/lb.
4. Humidity sensors at a minimum shall be accurate within +/- 3 percent full range between 20 and 95 percent, with drift less than 1 percent full scale per year.
5. Pressure transmitters at a minimum shall be accurate to +/- 1 percent full scale with drift less than 1 percent full scale per year.
6. Carbon dioxide (CO2) sensors shall measure total percentage of CO2 in ppm. Sensor shall have an accuracy of plus/minus 75 ppm at a 600 and 1000 ppm concentration and certified by the manufacturer to require calibration no more frequently than once every 5 years.

C. Provide remote sensors where indicated on the drawings and integrate them with the thermostat control equipment. Remote sensors shall have the following features:

1. Wired connection.
2. Temperature sensor.
3. Blank faceplate.
4. At contractor's option where multiple remote sensors are shown for a single unit, the sensors may be provided in a single device.

D. Provide CO2 sensors by Honeywell, Telair, Toxalert, Veris, or equal. Sensor shall be equipped with digital display to continuously display reading.

E. Smoke detectors furnished and installed as indicated in this section or as scheduled on the plans (or heat detectors, if permitted by code) shall shut down each associated unit supply fan upon activation where required by code. Provide remote visual and audible alarm device in an approved location if smoke detectors are not connected to a fire alarm panel and label device as "Air Duct Detector Trouble".

F. Provide 24 Volt or 120 Volt timeswitches Intermatic Series FM1D20 or equal programmable type with 7-day programming with up to two "ons" and "offs" per day. Battery backup shall provide 48 hours of memory retention. Override timer switches shall be spring wound, 6-hour, normally open type. Coordinate 120 V wiring of timeswitch with electrical contractor if 120 V model is provided.

G. Provide relays with contact rating, configuration, and coil voltage that is suitable for the application. Relay shall be general purpose, enclosed plug-in type and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required. Transient suppression shall be provided as an integral part of the relay. Contactors shall be single coil, electrically operated, mechanically held, double-break, silver-to-silver type protected by arcing contacts. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Operating and release times shall be 100 milliseconds or less.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Install control devices with top of device at 48 inches AFF to meet ADA requirements unless otherwise noted on the plans.

C. Coordination:

1. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

3.2 STARTUP AND DEMONSTRATION

A. Control system shall be set up and checked by factory trained technicians skilled in the setting and adjustment of the equipment used in this project. Technician shall be experienced in the type of HVAC systems associated with this project.

B. At the completion of the startup, this contractor shall demonstrate the sequence of operations for each system to the Architect, Owner, or his representative.

3.3 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of eight hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
2. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

C. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 230924

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SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes refrigerant piping used for air conditioning applications. This Section includes:

1. Pipes, tubing, fittings, and specialties.
2. Special duty valves.
3. Refrigerants.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 02 Section "Earthwork," for trenching and backfilling materials and methods for underground piping installations.
2. Division 07 Section "Penetration Firestopping," for materials and methods for fire barrier penetrations.
3. Division 07 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.
4. Division 23 Section "Identification for HVAC Piping & Equipment," for labeling and identification of refrigerant piping.
5. Division 23 Section "Common Work Results for HVAC" for materials and methods for wall and floor penetrations and equipment pads.
6. Division 23 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
7. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, saddles and materials and methods for hanging and supporting refrigerant piping.
8. Division 23 Section "HVAC Insulation," for materials and methods for insulating refrigerant piping.

1.2 SUBMITTALS

A. Product data for the following products:

1. Each type valve specified.
2. Each type refrigerant piping specialty specified.

B. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and proximate to equipment.

C. Brazer's Certificates signed by Contractor certifying that brazers comply with requirements specified under "Quality Assurance" below.

D. Test reports specified in Part 3 below.

E. Maintenance data for refrigerant valves and piping specialties, for inclusion in Operation and Maintenance Data specified in Division 01 and Division 23 Section "General Mechanical Requirements."

1.3 QUALITY ASSURANCE

A. Qualify brazing processes and brazing operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications".

B. Regulatory Requirements: Comply with provisions of the following codes:

1. ASME/ANSI B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
2. ASME/ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.
3. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.
4. Mechanical Code.

C. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Refrigerant Valves and Specialties:

a. Alco Controls Div, Emerson Electric.
b. Danfoss Electronics, Inc.
c. EATON Corporation, Control Div.
d. Henry Valve Company.
e. Parker-Hannifin Corporation, Refrigeration and Air Conditioning Division.
f. Sporlan Valve Company.

2.2 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3, Article "PIPE APPLICATION" for identification of systems where the below specified pipe and fitting materials are used.

B. Copper Tubing:

1. ASTM B280, Type ACR, seamless, hard-drawn straight lengths and soft-annealed coils. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.
2. ASTM B88, Type L, seamless, hard-drawn straight lengths and soft-annealed coils.
3. ASTM B88, Type K, seamless, hard-drawn straight lengths and soft-annealed coils.

C. Refrigerant Line Kits:

1. Type ACR seamless copper roll of refrigerant tubing with pipe diameters as recommended by the manufacturer and of length as required for the installation.
2. Factory or field installed flexible unicellular insulation:

a. Minimum thickness as required per Division 23 section “HVAC Insulation”.

3. Quick-connect flare tubing compression fittings or solder connections as required to match the connections of the condensing unit and evaporator coil.

2.3 FITTINGS

A. Wrought-Copper Fittings for Solder-joint: ANSI B16.22, streamlined pattern.

B. Mechanical Flared Fittings: ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tube.

2.4 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony.

B. Brazing Filler Metals:

1. AWS A5.8, Classification BAg-5.

a. Silver (Ag) 44.0 – 46.0%
b. Zinc (Z) 23.0 – 27.0%
c. Copper (Cu) 29.0 – 31.0%.

2. AWS A5.8, Classification BCuP – 5.

a. Phosphorus (P) 4.8 - 5.2%
b. Silver (Ag) 14.5 - 15.5%
c. Copper (Cu) remainder.

2.5 VALVES

A. General: Complete valve assembly shall be UL-listed and designed to conform to AHRI 760. Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

B. Globe: 450 psig maximum operating pressure, 275 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections.

C. Check Valves - Smaller Than 7/8 inch: 500 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast brass body, with removable piston, Teflon seat, and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections.

D. Check Valves - 7/8 inch and Larger: 450 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.

E. Solenoid Valves: 250 deg. F temperature rating, 400 psig working pressure; forged brass, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, and 24 volt, 60 Hz. normally closed holding coil.

F. Evaporator Pressure Regulating Valves: pilot-operated, forged brass or cast bronze; complete with pilot operator, stainless steel bottom spring, pressure gage tappings, 24 volts DC, 50/60 Hz, standard coil; and wrought copper fittings for solder end connections.

G. Thermal Expansion Valves: thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves

shall have copper fittings for solder end connections; complete with sensing bulb, a distributor having a side connection for hot gas bypass line, and an external equalizer line.

H. Hot Gas Bypass Valve: adjustable type, sized to provide capacity reduction beyond the last step of compressor unloading; and wrought copper fittings for solder end connections.

2.6 REFRIGERANT PIPING SPECIALTIES

A. General: Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to AHRI 760.

B. Strainers: 500 psig maximum working pressure; forged brass body with Monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.

C. Moisture/liquid Indicators: 500 psig maximum operation pressure, 200 deg. F maximum operating temperature; forged brass body, with replaceable polished optical viewing window, and solder end connections.

D. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets, as follows:

1. Standard capacity desiccant sieves to provide micronic filtration.
2. High capacity desiccant sieves to provide micronic filtration and extra drying capacity.

E. Suction Line Filter-Drier: 350 psig maximum operation pressure, 225 deg. F maximum operating temperature; steel shell, and wrought copper fittings for solder end connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.

F. Suction Line Filters: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter core kit, including gaskets, as follows:

G. Flanged Unions: 400 psig maximum working pressure, 330 deg. F maximum operating temperature; two brass tailpiece adapters for solder end connections to copper tubing; flanges for 7/8 inch through 1-5/8 inch unions shall be forged steel, and for 2-1/8 inch through 3-1/8 inch shall be ductile iron; four plated steel bolts, with silicon bronze nuts and fiber gasket. Flanges and bolts shall have factory-applied rust-resistant coating.

H. Flexible Connectors: 500 psig maximum operating pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length.

2.7 REFRIGERANT

A. Refrigerant No. 410A, in accordance with ASHRAE Standard 34.

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

A. Above Grade:

1. Type L or Type ACR tubing.

B. Below Grade and Within Slabs:

1. Use Type K tubing for 2 inch and smaller without joints. Mechanical fittings (crimp or flare) are not permitted.
2. Install tubing in insulated PVC or HDPE protective conduit. Vent conduit to the outdoors.

C. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in Article "CLEANING" below.

D. At contractor's option, use refrigerant line kits for refrigerant systems of 5 tons and smaller capacity.

3.2 PIPING INSTALLATIONS

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 - "The Safety Code for Mechanical Refrigeration" and the equipment manufacturer's installation requirements.

B. Install piping in as short and direct arrangement as possible to minimize pressure drop.

C. Install piping for minimum number of joints using as few elbows and other fittings as possible.

D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

F. Insulate piping per Division 23 Section "HVAC Insulation."

1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

G. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

H. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

I. Slope refrigerant piping as follows:

1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.
2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
4. Liquid lines may be installed level.

J. Use fittings for all changes in direction and all branch connections.

K. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

L. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

M. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, unless indicated to be exposed to view.

N. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

O. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

P. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal. Refer to Division 23 Section “Basic Piping Materials and Methods” for additional information.

Q. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 07 Section “Penetration Firestopping” for special sealers and materials.

R. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 23 Section “Basic Piping Materials and Methods” for additional information.

S. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Common Work Results for HVAC” for special sealers and materials.

T. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

U. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

3.3 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Conform to the table below for maximum spacing of supports:

1. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing. Provide plastic galvanic isolators for copper tubing where indicated.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

3. Pipe rollers complete supports for multiple horizontal runs, 20 feet or longer supported by a trapeze.
4. Spring hangers to support vertical runs.
5. Provide insulation saddles and protection shields as specified in Section “Hangers & Supports for HVAC Piping & Equipment”. Provide insulation inserts as specified in Section “HVAC Insulation”.

C. Install hangers with the following minimum rod sizes and maximum spacing:

NOM. PIPE SIZE	MAX. SPAN-FT	MIN. ROD SIZE – INCHES
Up to 3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8
2-1/2	9	1/2
3	10	1/2
4	12	1/2
6	14	5/8

D. Support vertical runs at each floor.

E. Install a support within one foot of each change of direction.

3.4 PIPE JOINT CONSTRUCTION

A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
2. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do not apply heat near the bulb of the expansion valve.

B. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.

C. Dissimilar metals such as copper and brass shall be joined using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.

D. Continuously purge the pipe and fittings during brazing, with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.

E. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.

3.5 VALVE AND PIPING SPECIALTIES INSTALLATIONS

A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.

B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.

C. Install a full sized, 3-valve bypass around each drier.

D. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.

1. Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.

E. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.

1. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.
2. Install the valve in such a location so that the diaphragm case is warmer than the bulb.
3. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.
4. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.

F. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

G. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

H. 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.

1. Install moisture/liquid indicators in lines larger than 2-1/8 inch OD, using a bypass line.

3.6 EQUIPMENT CONNECTIONS

A. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow servicing and maintenance.

3.7 FIELD QUALITY CONTROL

A. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI. Provide test report summarizing the test procedures and results of the tests.

B. Repair leaking joints using new materials, and retest for leaks.

C. Field Test: Every refrigerant-containing part of every system that is erected on the premises, except safety devices, pressure gauges, control mechanisms, compressors, evaporators, and systems that are factory-tested, shall be tested and proved tight after complete installation and before operation. The high side and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high side and low side of the system, respectively.

D. Testing Procedure: Tests shall be performed with dry nitrogen. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gage on the outlet side. The pressure-relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system’s components.

3.8 CLEANING

A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:

1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
3. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.9 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping systems in accordance with requirements of Division 23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.10 STARTUP

A. Charge system using the following procedure:

1. Install core in filter dryer after leak test but before evacuation.
2. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

C. Review data in Operating and Maintenance Manuals. Refer to Division 01 section "Closeout Procedures."

D. Schedule training with Owner through the Architect, with at least 7 days advance notice.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes:

1. Rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gauge.
2. Duct liner.
3. Wire rope hanging system.

B. Related Sections:

1. Division 7 Section "Penetrations Firestopping," for materials and methods for fire barrier penetrations.
2. Division 7 Section "Joint Sealers," for materials and methods for sealing duct penetrations through basement and foundation walls.
3. Division 23 Section "Identification for HVAC Piping & Equipment," for labeling and identification of metal ducts.
4. Division 23 Section "Common Work Results for HVAC," for materials and methods for wall penetrations and equipment pads.
5. Division 23 Section “Seismic Controls for Mechanical Systems,” for seismic controls.
6. Division 23 Section “Particulate Air Filtration” for filter requirements.

1.2 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.4 SUBMITTALS

A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:

1. Duct Liner.
2. Sealing Materials.
3. Fire-Stopping Materials.

B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire-rated and other partitions.
7. Terminal heating and cooling unit, coil, humidifier and duct silencer installations.
8. Locations of fire and fire/smoke dampers and associated duct access doors.
9. Locations of cleanout and access doors in grease exhaust ducts.
10. Location of manual balancing dampers.
11. Duct smoke detector locations. Refer to electrical drawings for general locations and coordinate locations with the electrical contractor.
12. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:

1. Coordination with ceiling suspension members.
2. Spatial coordination with other systems installed in the same space with the duct systems.
3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

D. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.

E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

F. Deferred Submittals: Submit signed and sealed drawings that indicate the design and installation requirements of pre-engineered roof supports can withstand the design criteria listed in this specification. Include installation requirements for anchoring to the roof structure. The Engineer is not responsible and will not provide the seal and signature. Deliver submittal to the local AHJ for approval prior to installation of the contractor provided, pre-engineered roof supports.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."

B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.

C. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
2. NFPA 90B, “Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
3. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.

D. Sheet Metal and Air Conditioning Contractors’ National Association, Inc. (SMACNA): Provide ductwork systems in conformance with “HVAC Duct Construction Standards – Metal and Flexible,” latest edition.

E. Underwriter’s Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.

F. Deferred Submittals: Signed and sealed by a professional engineer or National Institute for Certification in Engineering Technologies (NICET) stamp and signature. The professional engineer shall be licensed in the same state in which the project is located.

1.6 PROTECTION AND REPLACEMENT

A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.

B. Replace duct liner that is damaged and cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installing new duct liner.

PART 2 - PRODUCTS AND MATERIALS

2.1 SHEET METAL MATERIALS

A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A 700.

B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 653, Coating Designation G 90. Provide mill phosphatized or galvanealed finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.

C. PVC-Coated Galvanized Steel: UL-181 Class 1 Listing. Lock-forming quality galvanized sheet steel with ASTM A 653, Coating Designation G 90. Provide with factory-applied, 4-mil, PVC coating on the exposed surfaces of ducts and fittings (exterior of ducts and fittings for underground applications, and the interior of ducts and fittings for fume-handing applications) and 2-mil PVC coating on the reverse side of the ducts and fittings.

D. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.

E. Stainless Steel: ASTM A 480, Type 316, sheet form, with No. 4 finish on exposed surface for ducts exposed to view; Type 304, sheet form, with No. 1 finish for concealed ducts.

F. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.

G. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

A. General:

1. Comply with NFPA Standard 90A and North American Insulation Manufacturers Association (NAIMA) Standard AHC-101.
2. Liner shall have a flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84 or UL 723.
3. Duct sizes on mechanical plans indicate clear inside airflow dimensions. Sheet metal sizes for ductwork with duct liner shall be increased accordingly to account for liner thickness.

B. Fiberglass: ASTM C 1071, Type I or II, glass fibers firmly bonded together with a thermosetting resin with surface exposed to airstream coated to prevent erosion of glass fibers. Liner surface shall serve as a barrier against infiltration of dust and dirt, shall meet ASTM C 1338 for fungi resistance and shall be cleanable using duct cleaning methods and equipment outlined by NAIMA Duct Cleaning Guide. Duct liner shall be rated for air velocity of 6,000 fpm.

1. Rectangular fiberglass duct liner shall be Certainteed ToughGard T, JohnsManville Linacoustic RC, Knauf Atmosphere, Owens Corning QuietR or approved equal.

a. Thickness and Density:

1) 1 inch, 1-1/2 pounds.

2. Round fiberglass duct liner shall be Certainteed ToughGard UltraRound, JohnsManville Spiracoustic Plus, Owens Corning QuietZone Spiral, or approved equal.

a. Thickness and Density:

1) 1 inch, 4 pound.

3. Thermal Performance: Meet minimum "K-Factor" equal to 0.24 (Btu·in/h·sq ft·F) or better, at a mean temperature of 75°F and rated in installed condition in accordance with ASTM C518 and/or ASTM C177.
4. Noise Reduction Coefficient (NRC): Meet the following minimum NRC in accordance with ASTM C423 Type A Mounting:

a. 1 Inch Thick: NRC 0.65.

5. Liner Adhesive: Comply with NFPA Standard 90A /UL 181 classified with flame spread/smoke development less than 25/50 and ASTM C 916. Adhesive shall be a minimum 50% solid content, water-based, non-oxidizing and have a service temperature of –20 to 200 F. Water-based adhesive shall be one of the following:

a. Armacell LLC Armaflex 520 BLV.
b. Design Polymerics DP 2502.
c. Duro Dyne WIT.
d. Foster 85-60.
e. Childers CP-127.
f. Johns Manville SuperSeal HV.
g. Hardcast 951.
h. United McGill Uni-Tack.

6. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.

a. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.
b. Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

2.3 SEALING MATERIALS

A. Joint and Seam Sealants, General:

1. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.
2. Duct tape shall not be used as a sealant on any ducts.
3. Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.

B. Joint and Seam Tape: 2 inches wide, glass-fiber-reinforced fabric.

C. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

D. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 70 percent solids.

1. Manufacturers:

a. Childers CP-140.
b. Duro Dyne SGD.
c. Fosters 32-14.
d. Approved equal.

E. Water-Based Joint and Seam Sealant, Non-Fibrated: UL 181 listed. Sealant shall be rated to ±15 inches w.g. Sealant shall have a service temperature of –25 to 200 F and be freeze/thaw stable through 5 cycles.

1. Manufacturers:

a. Childers CP-146.
b. Design Polymerics DP 1010.
c. Ductmate Proseal/Fiberseal.
d. Duro Dyne Duroseal.
e. Fosters 32-19

f. United Duct Sealer (Water Based).
g. Hardcast 601.

F. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

G. Flanged Gasket Tapes: Butyl gasket shall be UL 181 classified. Gasket size shall be minimum 5/8 inch x 3/16 inch and have nominal 100 percent solid content. It shall be non-oxidizing, non-skinning and have a service temperature of –25 to 180 F.

1. Manufacturers:

a. Design Polymerics DP 1040.
b. Ductmate 440.
c. Hardcast 1902.

2.4 FIRE-STOPPING

A. Fire-Resistant Sealant: Two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Resistant Sealant: One-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

C. Products: Subject to compliance with requirements, provide one of the following:

1. "3M Fire Stop Foam"; 3M Corp.
2. "SPECSEAL Pensil 200 Silicone Foam"; Specify Technology, Inc.
3. 3M Fire Stop Sealant"; 3M Corp.
4. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
5. "Fyre Putty"; Standard Oil Engineered Materials Co.
6. “FS-ONE”, Hilti, Inc.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.

B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.

1. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
2. Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
2. For stainless steel ducts, provide stainless steel support materials.
3. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

E. Pre-engineered roof duct supports:

1. Manufacturers:

a. Cooper B-Line, Inc.
b. Elite Components.
c. ERICO/Caddy.
d. Ferguson/FNW.
e. Miro.
f. PHD Manufacturing.
g. PHP Systems/Design.
h. Roof Top Blox.
i. Unistrut, a brand of Atkore International Inc.
j. Zsi Foster.

2. General: Pre-engineered devices with embedded duct support fixtures as specified.
3. Pedestals: Steel pedestals with thermoplastic or rubber base with the following dimensions:

a. Up to 12 inch strut length support: 18 inch x 18 inch.
b. Up to 16 inch strut length support: 24 inch x 18 inch.
c. Up to 24 inch strut length support: 30 inch x 18 inch.
d. Thickness: Minimum 3/16 inch thick.

4. Block Bases: Closed-cell polyethylene blocks with the following dimensions.

a. Length: Nominal 10 inch, 12 inch, 16 inch, or 24 inch
b. Width: Nominal 4 inches.

5. Attachment/Support Fixtures: As recommended by manufacturer, with straps or crossbar over top of duct to prevent movement.
6. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
7. Pre-Engineered Duct Support Rails:

a. Manufacturers:

1) AES Industries.
2) Custom Curb, Inc.
3) Pate Company.
4) Thybar.

b. Construction:

1) Base plate designed to be attached to building structure, with fully mitered raised cant and step to match roof insulation thickness.
2) Welded, minimum 18 gauge galvanized steel shell, internally reinforced to load bearing factors of equipment being supported.

3) Factory installed treated wood nailer.
4) 4 inch, minimum 18 gauge nailer jacket with counterflashing where equipment will not fully cover the support.

F. Wire Rope Hanging Systems:

1. Manufacturers:

a. Anvil International.
b. Ductmate Industries, Inc; Clutcher Cable Hanging System.
c. Duro Dyne.
d. Gripple.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
4. Wire Rope: Zinc coated or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.
5. Cable Lock: Cast zinc housing with steel spring with wedge grip, selected to meet the vertical load applied to the hanging system and wire thread. Do not exceed the working load limit.
6. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.
7. Seismic Applications: Wire rope hanger systems used for seismic supports shall be seismically tested according to ICC code guidelines EG284 with UL and SMACNA seismic approvals. Reference Division 23 Section “Seismic Controls for Mechanical Systems” for additional requirements.

2.6 RECTANGULAR DUCT FABRICATION

A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Tables 2-1 through 2-28, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.
2. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
3. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.

C. Exterior Ductwork: Ductwork installed exterior to the building without weather-proof jacket or cladding shall be minimum #18 gauge with longitudinal and transverse joints welded or sealed airtight as specified under Paragraph “Seam and Joint Sealing”.

D. Field Painted Ductwork: Provide mill phosphatized finish on exposed surfaces of rectangular ductwork and duct fittings to be field painted.

2.7 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.

B. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

C. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer’s approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section “Ductwork Accessories” for turning vane construction and mounting.

2.8 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.

B. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

E. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

1. Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.

F. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

G. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

1. Fan discharge.
2. Intervals of lined duct preceding unlined duct.
3. Upstream edges of transverse joints in ducts where duct velocity is greater than 2,500 FPM.

H. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

2.9 ROUND DUCT FABRICATION

A. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round ducts in lengths not less than 12 feet.

1. Fabricate round ductwork of minimum 26 gauge sheet metal.

B. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.

C. Field Painted Ductwork: All round and duct fittings to be field painted shall have galvanized metal primer applied in the shop after fabrication and prior to shipping.

2.10 ROUND SUPPLY AND EXHAUST FITTINGS FABRICATION

A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-5, 3-6 and 3-7 and with metal thickness specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

C. Elbows: Unless elbow construction type is indicated, provide elbows meeting the following requirements:

1. Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter.

a. Elbows in Round Duct: Provide full radius elbows.
b. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.
c. Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section “Basic Mechanical Materials and Methods” for noise critical spaces.

2. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.

a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-1.

b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

1) 3 to 26 inches: 24 gauge.
2) 27 to 36 inches: 22 gauge.
3) 37 to 50 inches: 20 gauge.
4) 52 to 60 inches: 18 gauge.
5) 62 to 84 inches: 16 gauge.

c. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:

1) 3 to 14 inches: 24 gauge.
2) 15 to 26 inches: 22 gauge.
3) 27 to 50 inches: 20 gauge.
4) 52 to 60 inches: 18 gauge.
5) 62 to 84 inches: 16 gauge.

d. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.

3. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
4. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.
5. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
6. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.
7. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.
8. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gauge.

D. Double-Wall (Insulated) Fittings: Fabricate double-wall insulated fittings with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.

1. Outer Shell: Base outer shell gauge on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation. Gauges for outer shell shall be same as for uninsulated fittings specified above.
2. Insulation: Unless otherwise indicated, provide 1-inch-thick fiber-glass insulation with thermal conductivity performance of 0.27 Btu/sq.ft./°F/inch-thickness at 75°F mean temperature. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.
3. Solid Inner Liner: Construct round inner liners with solid sheet metal of the gauges listed below.
4. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

2.11 FACTORY-MANUFACTURED DUCTWORK

A. Manufacturers:

1. Hercules Industries.
2. Lewis & Lambert.
3. Lindab Safe.
4. Linx Industries, Inc.
5. Semco.
6. Approved equal.

B. General: At the Contractor’s option, factory-manufactured ductwork can be provided instead of fabricated ductwork for round and oval ductwork. The round duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer.

C. Duct Construction

1. Unless otherwise noted, all duct and fittings shall be constructed from galvanized steel in accordance with SMACNA's Duct Construction Standards for +10” water gauge pressure with thickness as shown in the following tables:

Single Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct	Galvanized Fittings
3-14	28	24
15-24	26	24
26-42	24	22
42-60	22	20

Double Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct		Galvanized Fittings	
	Inner	Outer	Inner	Outer
3-14	28	28	24	24
16-24	26	26	24	24
26-42	24	24	22	22
44-60	22	22	20	20

2. Duct shall be calibrated to manufacturer's published dimensional tolerance standard.
3. All duct 14" diameter and larger shall be corrugated for added strength and rigidity.
4. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.
5. Ducts shall be constructed using spiral lock seam sheet metal construction.
6. Ductwork to be installed in exposed locations shall have the surface prepared in the factory for field painting.

D. Fittings:

1. All fitting ends for round duct and transitions and divided flow fittings smaller than 50” diameter that convert oval duct to round duct shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility

so as to insure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.

2. All fittings shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.
3. All fitting ends from 5" to 60" diameter shall have rolled over edges for added strength and rigidity.
4. All elbows from 5" to 12" diameter shall be 2 piece die stamped and continuously stitch welded. All elbows 14" diameter and larger shall be standing seam gorelock construction and internally sealed.
5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0. The radius of all 15°, 30° and 60° elbows shall be 1.0 times the elbow diameter.
6. All fittings that are of either spot welded or button punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct taps is unacceptable except for retrofit installations.
7. Double wall duct and fittings shall consist of a perforated or solid inner liner, a 1 inch, 1.50 lb/ft3 (unless otherwise specified) layer of fiberglass insulation and a solid outer pressure shell. Perforated inner liner shall have a retaining fabric wrapped between the perforated inner and the fiberglass insulation. This fabric shall provide fiberglass tear retention while maintaining the desired acoustical properties. For 1 inch thick insulation, the outer pressure shell diameter shall be 2 inches larger than the inner liner.
8. All double wall fittings for round duct shall be furnished with the Lindab Safe gasket on the outer shell. The inner shell on all double wall fittings shall extend a minimum of 1 inch past the outer shell.
9. Double wall to single wall transitions shall be provided where insulated duct connects to non-insulated, single wall duct. Transitions shall also act as insulation ends reducing the double wall outer shell diameter to the inner shell diameter.
10. All double wall duct and fittings shall be furnished with both an inner liner and an outer pressure shell coupling. The inner liners shall not be fastened tighter to allow for expansion and contraction.
11. All volume dampers shall be Lindab Safe type DRU, DSU or DTU or approved equal. Damper shall be fitting sized to slip into spiral duct. Damper shall have the following features:

    a. Locking quadrant with blade position indicator.
    b. 2" sheet metal insulation stand-off.
    c. Integral shaft/blade assembly.
    d. Shaft mounted, load bearing bushings.
    e. Gasketed shaft penetrations to minimize leakage.

2.12 SNAP-LOCK DUCT SYSTEM

A. General: At Contractor’s option, snap-lock round ductwork can be provided instead of fabricated ductwork for round ductwork up to 14” in diameter in air systems with pressures between negative 1” and positive 2” w.c..

B. Duct Construction:

1. Material:

    a. Galvanized steel conforming to ASTM A653 and A924 with G-60 galvanized coating conforming to ASTM A653 and ASTM A90.

2. Duct shall be minimum 26 gauge. Duct shall be self-locking and incorporate a factory applied gasket in the longitudinal seam and the female end of the traverse joint to provide a system that meets SMACNA Seal Class A.
3. Fittings: Minimum 26 gauge. All high-efficiency take-offs, conicals, and collars shall have a factory applied gasket along all rivets, co-latches, and flanges. Dampered fittings shall have low leakage hardware with closed-end bearings.

C. Gaskets: Butyl and EPDM rubber that meets flame spread index of 25 and smoke spread index of 50 according to ASTM E84.

D. Manufacturers:

1. Ductmate GreenSeam.
2. Approved equal.

PART 3 - EXECUTION

3.1 DUCT MATERIAL APPLICATION

A. All ducts shall be galvanized steel except as follows:

1. Exterior Ductwork: Ductwork installed exterior to the building shall be minimum #18 gauge with longitudinal and transverse joints welded or sealed airtight as specified under Paragraph “Seam and Joint Sealing”.

3.2 DUCT LINER INSTALLATION

A. Fiberglass Duct Liner:

1. Attach fiberglass duct liner using fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.

B. Application: Provide duct liner on the following interior air ducts and where specified on the drawings.

1. Supply Ductwork:

a. Exposed rectangular ductwork.
b. Exposed round ductwork.
c. First 15 feet of ductwork downstream of equipment outlets.

2. Return Ductwork.

a. Exposed rectangular ductwork.
b. Exposed round ductwork.
c. First 15 feet of ductwork upstream of equipment outlets.

3.3 DUCT INSTALLATION, GENERAL

A. Install products in accordance with manufacturer’s instructions.

B. Duct System Pressure Class: Construct and install each duct system except factory-manufactured ductwork for the specific duct pressure classification indicated. For factory-manufactured ductwork, refer to Paragraph “Factory-Manufactured Ductwork”.

1. Supply Air Ducts: 3 inches water gauge.
2. Primary Supply Air Ducts (upstream of terminal boxes): 4 inches water gauge.
3. Secondary Supply Air Ducts (downstream of terminal boxes): 2 inches water gauge
4. Return and Outdoor Air Ducts: 2 inches water gauge, negative pressure.
5. Exhaust Air Ducts: 2 inches water gauge, negative pressure.

C. Install ducts with the fewest possible joints.

D. Seal duct joints with the appropriate sealing material.

E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.

J. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

K. Install insulated ducts with 1-inch clearance outside of insulation.

L. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

M. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

N. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.

O. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

P. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

3.4 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints as follows:

1. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.
2. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized.

B. Seal externally insulated ducts prior to insulation installation.

C. Ductwork installed exterior to the building shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.

3.5 HANGING AND SUPPORTING

A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in Chapter 5 of the SMACNA "HVAC Duct Construction Standards", 2005 Edition.

B. Installation of Wire Roper Hanger Systems:

1. Install in accordance with manufacturer’s instructions.
2. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer’s recommended load rating.
3. Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.

C. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

D. Support vertical ducts at a maximum interval of 16 feet and at each floor.

E. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.

F. Install concrete insert prior to placing concrete.

G. Install powder actuated concrete fasteners after concrete is placed and completely cured.

H. Installation of Pre-Engineered Roof Duct Supports:

1. Install pre-engineered roof duct supports to rest on the roofing membrane without attachment to the roof structure or penetration through the roofing assembly.
2. Install pre-engineered roof duct supports anchored to the roof structure.

a. Install supports to meet the specified design criteria.

1) Building Design Risk Category: [II][III or IV].
2) Design Wind Speed: [XXX] mph.

b. Coordinate with the pre-engineered roof duct support manufacturer to anchor the duct supports directly to the roof structure in accordance with the manufacturer’s installation

instructions or provide intermediate duct supports engineered to meet the design criteria.

c. Submit design and installation requirements as a Deferred Submittal.

d. Pre-Engineered Duct Support Rails: Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope. Install supports to maintain continuous insulation on roof.

3. Refer to Section “Seismic Controls for Mechanical” for seismic bracing requirements.

3.6 PENETRATIONS

A. Fire Barrier Penetrations: Where ducts pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.

B. Exterior Wall Penetrations: Seal duct penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 23 Section “Basic Mechanical Materials and Methods” for additional information.

C. Underground Exterior Wall Penetrations: Seal duct penetrations through underground exterior walls with sleeves, packing, and sealant. Refer to Division 23 Section “Basic Piping Materials and Methods” for additional information.

D. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Seal ducts that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Basic Mechanical Materials and Methods” for special sealers and materials.

3.7 CONNECTIONS

A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."

B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 4-5 and 4-6.

C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 7-6 and 7-7. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor’s option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."

D. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 7-8.

3.8 FIELD QUALITY CONTROL

A. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.

B. If permanent HVAC equipment is used during the construction period, provide temporary filters at all openings in the ductwork and at inside equipment to protect the system from dust, dirt, paint, and moisture. Replace and maintain filters when needed, but not less than every month. On the day of substantial completion, clean the duct system and provide a new set of filters in the HVAC unit.

1. Refer to Division 23 Section 234100 Particulate Air Filtration for filter requirements.

3.9 ADJUSTING AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "TESTING, ADJUSTING, AND BALANCING FOR HVAC" for requirements and procedures for adjusting and balancing air systems.

B. Vacuum duct systems prior to final acceptance to remove dust and debris.

3.10 CLEANING NEW SYSTEMS

A. Contractor shall clean the HVAC systems in accordance with NADCA.

B. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

C. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

D. Vent vacuuming system to the outside. Provide filtration and/or containment systems to keep debris removed from HVAC systems from contaminating other spaces. Locate exhaust down wind and away from air intakes and other points of entry into building.

E. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply and outdoor air ducts, dampers, actuators, and turning vanes.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment while the system is under negative pressure; do not permit duct liner to get wet.
5. Clean coils and coil drain pans according to ACR 2002. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

G. Disposal: Debris collected from the HVAC system shall be disposed of in accordance with applicable federal, state and local requirements.

H. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and re-inspect ducts.

3.11 CLEANING EXISTING SYSTEMS

A. Contractor shall clean the HVAC systems in accordance with NADCA.

B. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Use existing service openings where possible.
2. Create other openings to comply with duct standards.
3. Disconnect flexible ducts as needed for cleaning and inspection.
4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
5. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.

E. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply and outdoor air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment while the system is under negative pressure; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to ACR 2002. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide operative drainage system for wash down procedures.
7. Biocidal Agents and Coatings: Apply biocidal agents, Design Polymer DP 2545, Foster 40-20 or approved equal, if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

G. Disposal: Debris collected from the HVAC system shall be disposed of in accordance with applicable federal, state and local requirements.

H. Cleanliness Verification:

1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and re-inspect ducts.

I. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

END OF SECTION 233113

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SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this Section.

B. Types of ductwork accessories required for project include the following:

1. Dampers.
    a. Low pressure manual dampers.
    b. Counterbalanced backdraft dampers.
2. Cable operated damper systems.
3. Fire and smoke dampers.
4. Turning vanes.
5. Duct hardware.
6. Duct access doors.
7. Flexible ductwork.
8. Flexible elbow assembly.
9. Metal duct connectors.
10. Flexible duct connectors.

C. Refer to other Division 23 Sections for testing, adjusting, and balancing of ductwork accessories; not work of this Section.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Codes and Standards:

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible", 2005 Edition.
2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
3. UL Compliance:
    a. Construct, test, and label fire dampers in accordance with current edition of UL Standard 555 "Fire Dampers". Construct, test, and label smoke dampers in accordance with current edition of UL Standard 555S "Smoke Dampers".
    b. Construct flexible ductwork in compliance with UL Standard 181 “Factory-Made Air Ducts and Connections”.
    c. Duct tape shall be labeled in accordance with UL Standard 181B and marked 181B-FX.
    d. Duct clamps shall be labeled in accordance with UL Standard 181B and marked 181B-C.
4. NFPA Compliance:

a. Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories. Comply with NFPA 90B “Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

5. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 “Surface Burning Characteristics” (NFPA 255) method.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory including dimensions, capacities and materials of construction; and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS AND MATERIALS

2.1 DAMPERS

A. Low Pressure Manual Dampers: Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards".

1. Material: Galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments.
2. Construction: Bearings shall be corrosion resistant, molded synthetic and axles shall positively lock into the damper blade. Extended shafts and standoff bracket for insulation clearance shall be metal material. Provide with locking quadrant.
3. Blade Seals: Where dampers are used for shutoff duty, provide Neoprene seals for round dampers and silicone for rectangular dampers.
4. Dampers shall be Greenheck Model MBD Series, or approved equal.

B. Control Dampers: Refer to Division 23 section Instrumentation and Control Devices for HVAC for control dampers; not work of this section.

C. Counterbalanced Backdraft Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to open at indicated static pressure. Construct frames and blades of minimum 16-ga aluminum. Provide minimum 1/2" diameter, corrosion-resistant bearings and 1/2" diameter, galvanized or stainless steel axles. Blade edge seals shall be mechanically locked into blade edge. Blade seals shall be neoprene for round dampers. Blade seals shall be silicone or vinyl for rectangular dampers.

D. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:

1. Air Balance, Inc.
2. Arrow United Industries.
3. Cesco
4. Greenheck
5. Louvers & Dampers, Inc.

6. Nailor Industries, Inc.
7. Pottorff
8. Ruskin Mfg. Co.
9. TAMCO
10. Vent Products

2.2 CABLE OPERATED DAMPER SYSTEMS

A. General: Where access to dampers through a hard ceiling is required, provide a concealed, cable operated volume damper with remote operator.

1. Damper shall be adjustable through the diffuser face or frame with standard 1/4” nutdriver or flat screwdriver.
2. Cable assembly shall attach to damper as one piece with no linkage adjustment.
3. Positive, direct, two-way damper control shall be provided with no sleeves, springs or screw adjustments to come loose after installation.
4. Provide cable length as required to span the distance from the damper to the remote operator location.
5. Support cable assembly to avoid bends and kinks in cable.

B. Where approved by Architect, a ceiling cup with cover plate can be used for access to cable operator.

C. Manufacturer: Subject to compliance with requirements, provide cable operated damper systems of one of the following:

1. Metropolitan Air Technology, Inc. (Reference model is RT-250 for round ducts, RT-200 for rectangular ducts, with RT-WGA operator).
2. Young Regulator Co. (Reference model is 5020-1200 for round ducts, 820-1200 for rectangular ducts, with RT-270-275 operator).

2.3 FIRE AND SMOKE DAMPERS

A. General: Provide fire, smoke, and fire/smoke dampers at locations indicated on the drawings. Damper ratings shall be as required to maintain the fire and/or smoke ratings noted on the architectural drawings. Provide duct access door for inspection and service to each fire, smoke, and fire/smoke damper and fusible link as required. Provide sleeves of length as required to meet the installed location. Damper assemblies shall be provided as a single unit from the manufacturer.

B. Fire Dampers: Comply with UL 555. Construct casings of minimum 22-ga galvanized steel or as required to maintain applicable UL classification. Construct casings of 20 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings. Fire dampers shall be dynamic-rated for closure under pressure. Provide fusible link rated at 160 to 165 degrees F unless otherwise indicated. Provide damper with positive lock in closed position and with the following additional features:

1. Damper Blade Assembly: Single-blade type.
2. Damper Blade Assembly: Multi-blade type.
3. Damper Blade Assembly: Curtain type with blades out of the airstream.
4. Blade Material: Match casing material.
5. Open-closed indication switch.

C. Fire/Smoke Dampers: Provide fire/smoke dampers, of types and sizes indicated, and with actuator as specified herein.

1. Dampers: Dampers shall be UL555 (current edition) classified fire damper of rating required for location installed, UL555S (current edition) classified smoke damper for leakage class II and rated for dual directional airflow. Fire/smoke dampers shall be rated for closure in ducts up to minimum velocity of 2,000 fpm and static pressure of 4” w.g. Construct casings of 16-ga galvanized steel. Construct casings of 16 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings. Construct blades of minimum 22 gauge thickness with airfoil or longitudinal grooved shape for airflow velocities up to 2,000 fpm and airfoil shape for airflow velocities greater than 2,000 fpm. Bearings shall be self-lubricating, turning in extruded hole in the frame. Jamb seals shall be flexible, stainless steel. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in to the blade edge. Linkage shall be concealed in the frame. Provide resettable temperature device rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated. Provide stainless steel spring loaded leakage seals in sides of casing, and [36" long wire leads for connecting smoke link to smoke detector,][terminal block for connection to the building fire alarm system] and the following additional features:

    a. Damper Blade Assembly: Single-blade type.
    b. Damper Blade Assembly: Multi-blade type.
    c. Blade Material: Match casing material.
    d. Open-closed indication switch.
    e. Temperature Limited Override.
    f. Test Switch.
    g. Smoke Detector.

2. Motor-Driven Actuators: Comply with UL 555S. Actuators shall be factory installed. All actuators shall open in 15 seconds or less and close in 15 seconds or less after alarm or smoke detection has occurred. Actuators shall be rated for a minimum of 20,000 cycles of operation. Provide motor-driven fire/smoke dampers in types and sizes indicated, with 120 Volt, two-position, fail close, electric motor designed to close and/or open damper between 7 and 15 seconds, motor mounting bracket, and with the following construction features:

    a. Unit Assembly: Motor mounted outside air stream.
    b. Unit Assembly: Motor mounted inside air stream.
    c. Motor shall be designed for power return open/spring closed operation.
    d. Provide automatic reset of damper upon cessation of detector (test or actual smoke detection), and normalization of duct air temperature.
    e. Provide with integral end switch.

D. Smoke Dampers: Provide Smoke dampers, of types and sizes indicated, and with actuator as specified herein.

1. Dampers: Dampers shall be UL555S (current edition) classified smoke damper for leakage class II and rated for dual directional airflow. Smoke dampers shall be rated for a minimum velocity of 2,000 fpm and pressure of 4” w.g. Construct casings of 16-ga galvanized steel. Construct casings of 16 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings. Construct blades of minimum 22 gauge thickness with airfoil or longitudinal grooved shape for airflow velocities up to 2,000 fpm and airfoil shape for airflow velocities greater than 2,000 fpm. Bearings shall be self-lubricating, turning in extruded hole in the frame. Jamb seals shall be flexible, stainless steel. Blade edge seals shall be silicone rubber mechanically locked in to the blade edge. Linkage shall be concealed in the frame. Provide stainless steel spring loaded leakage seals in sides of casing, terminal block for connection to the building fire alarm system, and the following additional features:

    a. Damper Blade Assembly: Single-blade type.
    b. Damper Blade Assembly: Multi-blade type.

c. Blade Material: Match casing material.
d. Open closed indication switches.
e. Test switch.
f. Smoke Detector.

2. Motor-Driven Actuators: Actuators shall be factory installed. Comply with UL 555S Provide motor-driven smoke dampers in types and sizes indicated, with 120 Volt, two-position, fail close, 24 Vac, two position, fail close, 24 Vac, modulating, electric motor designed to close and/or open damper between 7 and 15 seconds, motor mounting bracket, and with the following construction features:

a. Unit Assembly: Motor mounted outside air stream.
b. Unit Assembly: Motor mounted inside air stream.
c. Motor shall be designed for power return open/spring closed operation.
d. Provide automatic reset of damper upon cessation of detector (test or actual smoke detection), and normalization of duct air temperature.
e. Provide with integral end switch.

E. Manufacturer: Subject to compliance with requirements, provide fire and smoke dampers of one of the following:

1. Air Balance, Inc.
2. Cesco Products.
3. Greenheck
4. Louvers & Dampers, Inc.
5. Nailor Industries, Inc.
6. Pottorff
7. Prefco Products, Inc.
8. Ruskin Mfg. Co.

2.4 TURNING VANES

A. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.

B. Acoustical Turning Vanes: Provide acoustical turning vanes constructed of airfoil shaped aluminum extrusion with perforated faces and fiberglass fill in systems serving noise critical spaces. Refer to Section “Common Work Results for HVAC”.

C. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following:

1. Aero Dyne Co.
2. Anemostat Products Div.; Dynamics Corp. of America.
3. Ductmate Industries.
4. Duro Dyne Corp.
5. Elgen Manufacturing Co., Inc.
6. Hart & Cooley Mfg. Co.
7. Register & Grille Mfg. Co., Inc.
8. Sheet Metal Connectors, Inc.

2.5 DUCT HARDWARE

A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:

1. Ductmate Industries.
2. Elgen Manufacturing Co., Inc.
3. Ventfabrics, Inc.
4. Young Regulator Co.

2.6 DUCT ACCESS DOORS

A. General: Provide, where indicated on the drawings or where specified in Part 3 of this section, duct access doors of size allowable by duct dimensions with, unless otherwise noted on the drawings, minimum size of 10” by 10” and maximum size of 24” by 24”. Provide removable section of duct where duct size is too small for a 10” by 10” access door. Construct access doors in accordance with SMACNA “HVAC Duct Construction Standards – Metal and Flexible” and as specified herein. Label access doors for fire and smoke dampers as specified in Paragraph “Installation of Ductwork Accessories.

B. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one size hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.

C. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:

1. Air Balance Inc.
2. Ductmate Industries.
3. Duro Dyne Corp.
4. Greenheck.
5. Register & Grille Mfg. Co., Inc.
6. Ruskin Mfg. Co.
7. Ventifabrics, Inc.
8. Vent Products.
9. Zurn Industries, Inc.; Air Systems Div.

2.7 FLEXIBLE DUCT.

A. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regards to required quality of construction and materials. Flexible duct shall have fire retardant polyethylene or reinforced metalized protective vapor barrier as follows:

1. Low pressure (duct pressure class up to and including 2” w.g.) and medium pressure (duct pressure class greater than 2” up to and including 6” w.g.)

    a. Fire retardant polyethylene vapor barrier

        1) ATCO 80 Series
        2) Flexmaster Type 5B
        3) JPL Type PR Series
        4) Thermaflex Type G-KM

    b. Reinforced metalized vapor barrier

        1) ATCO 30 Series
        2) Flexmaster Type 5M
        3) JPL Type MHP Series
        4) Thermaflex Type M-KE

2. High pressure (duct pressure class over 6” w.g.)

    a. Fire retardant polyethylene vapor barrier

        1) Flexmaster Type 3B

    b. Reinforced metalized vapor barrier

        1) Flexmaster Type 3M
        2) Thermaflex Type M-KC

3. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.
4. Provide acoustical, fiberglass insulated duct with minimum R-value of R-6.0.

B. Manufacturer: Subject to compliance with requirements, provide flexible ductwork of one of the following:

1. ATCO Rubber Products.
2. Flexmaster.
3. JPL (J.P. Lamborn Co)
4. Thermaflex.

2.8 FLEXIBLE ELBOW ASSEMBLY

A. General: At Contractors option, in lieu of rigid sheet metal elbows at connections to air inlets and outlets in concealed spaces, provide flexible elbow assembly to air devices requiring a 90 degree elbow connection.

B. Flexible elbow assembly shall be constructed of durable composite material and UL listed for use in return air plenums with a turning radius of not less than 3 inches.

C. Flexible elbow assembly shall be FlexFlow Elbow as manufactured by Flexible Technologies, Inc., FlexRight Elbow as manufactured by Build Right Products or approved equal.

2.9 METAL DUCT CONNECTORS

A. Description: Factory-fabricated, slide-on transverse flange connectors, corners, cleats, gaskets, and components. Material, gauge, and shape shall match the connecting ductwork.

B. Manufacturers: Subject to compliance with requirements, provide duct connectors by one of the following or approved equal:

1. Ductmate Industries.
2. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.10 FLEXIBLE DUCT CONNECTORS

A. Fabric Material: Flame-retardant or noncombustible fabrics compliant with NFPA 701.

1. Metal-Edged Connectors: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of minimum 24 gauge galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
2. Indoor System, Flexible Connector Fabric: Glass fabric coated with neoprene.

a. Minimum Weight: 26 oz./sq. yd.
b. Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
c. Service Temperature: Minus 40 to plus 200 deg F.

3. Outdoor System, Flexible Connector Fabric: Glass fabric coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

a. Minimum Weight: 24 oz./sq. yd.
b. Minimum Tensile Strength: 225 lbf/inch in the warp and 300 lbf/inch in the filling.
c. Service Temperature: Minus 40 to plus 250 deg F.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Flexible connectors shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

D. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following:

1. Ductmate Industries.
2. Duro Dyne Corp.
3. Elgen Manufacturing Co., Inc.
4. Ventfabrics, Inc.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

C. Provide balancing dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.

D. Coordinate all smoke and fire/smoke damper installation, wiring, and checkout to ensure that the dampers function properly and that they respond to the proper fire alarm system signal.

E. Install ceiling radiation dampers per manufacturer’s instructions. Support damper assembly from structure.

F. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Vanes shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork.

G. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc, and equipment at the following locations: Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

1. At each change in direction and at maximum 50-foot (15-m) spacing.
2. Upstream [and downstream] from turning vanes.

H. Provide duct access door(s) as scheduled below, at each fire and smoke damper within 12 inches of the device to allow for testing and maintenance. Label each door (with minimum 1” lettering) indicating which damper type is served. Door should be capable of being fully opened or provide removable door.

DUCT ACCESS DOOR SCHEDULE

Duct Width/Depth	Door Size	Quantity
10” TO 12”	10 X 10	1
14” TO 18”	12 X 12	1
20” TO 36”	14 X 14	1
38” TO 54”	18 X 18	1
56” TO 72”	18 X 18	2 (1 EACH END)
74” TO 96”	20 X 20	2 (1 EACH END)

I. Install flexible duct in accordance with manufacturer’s instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.

1. Flexible duct runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.

2. Flexible ductwork shall be installed straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible duct fully extended minimizing compression.
3. Provide continuous length with no intermediate joints.
4. Support flexible duct from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.
5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.
6. Support straps/saddles shall be minimum 1-1/4” wide. Use of wire hanging systems shall utilize strap and connect wire to strap.

    a. Factory installed suspension systems are acceptable

7. Ductwork shall not be crimped against joist or truss members, pipes, conduits, etc.
8. The bend radius at the center line shall be equal to or greater than one duct diameter.

    a. Support bends approximately one duct diameter on both sides of bends.

9. Connections to ductwork and air devices shall have at least 1” overlap.

J. Provide rigid duct elbow or flexible elbow assembly where a 90 degree elbow is required at connection to air devices.

K. Provide flexible duct connections wherever ductwork connects to vibrating equipment and when transitioning between two different metallic duct materials (e.g., aluminum to galvanized steel). Construct flexible connections of fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.

L. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".

C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".

D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 233300

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SECTION 233413 - AXIAL HVAC FANS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of axial fans:

1. Propeller fans.
2. Circulation fans.
3. High Volume Low Speed (HVLS) fans.

1.2 REFERENCE STANDARDS

A. AMCA 99 – Standards Handbook.

B. AMCA 204 – Balance Quality and Vibration Levels for Fans.

C. AMCA 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

D. AMCA 230 – Laboratory Methods of Testing Air Circulation Fans for Rating and Certification.

E. AMCA 300 – Reverberant Room method for Sound Testing of Fans.

F. AMCA 301 – Certified Ratings Program Product Rating manual for Fan Sound Performance.

G. AMCA 311 – Certified Ratings Program Product Rating Manual for Fan Sound Performance.

H. UL 705 – Power Ventilators; Current Edition Including all Revisions.

I. UL 762 – Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition Including all Revisions.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:

1. Product data for selected models, including specialties, accessories, and the following:

a. Certified fan performance curves with system operating conditions indicated.
b. Certified fan sound power ratings.
c. Motor ratings and electrical characteristics plus motor and fan accessories. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
d. Materials gages and finishes, including color charts.
e. Dampers, including housings, linkages, and operators.

2. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
3. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

4. Maintenance data for axial fans, for inclusion in Operating and Maintenance Manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."

1.4 QUALITY ASSURANCE

A. AMCA Compliance:

1. Provide propeller fan products that meet performance requirements and are licensed to use the AMCA Seal.
2. Provide HVLS fans that are tested and labeled in accordance with AMCA 230.
3. Testing Requirements: The following factory tests are required for propeller, tubeaxial, mixed flow and vaneaxial fans:

a. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
b. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

B. UL Compliance: Fans and components shall be UL listed and labeled.

C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.5 SEQUENCING AND SCHEDULING

Coordinate the size and location of structural steel support members.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.7 FIELD CONDITIONS

A. Permanent fans may not be used for ventilation during construction.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Propeller Fans:

a. Acme Eng. & Mfg. Corp.

b. Carnes Company, Inc.
c. Cook (Loren) Co.
d. Greenheck Fan Corp.
e. Hartzell Fan, Inc.
f. PennBarry.
g. RuppAir Management Systems.
h. Twin City Fan Company

2. Circulation Fans:

a. Big Ass Fans.
b. Leading Edge Fans
c. Patterson

3. HVLS Fans:

a. Altra Air
b. Big Ass Fans.
c. Epic.
d. Greenheck.
e. Kelley Company
f. Rite Hite
g. Skyblade

2.2 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required for propeller fans:

1. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

2.3 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor: 1.5.

D. Belts: Oil-resistant, non-sparking, and non-static.

E. Motors: Refer to Section “Common Motor Requirements for HVAC Equipment” for requirements.

F. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.

2.4 PROPELLER FANS

A. General Description: Belt-driven or direct-drive propeller fans as indicated consisting of fan blades, hub, housing, orifice ring, motor, drive, and accessories. Fans shall be rated for medium or heavy duty to meet specified conditions.

B. Housings: Galvanized, sheet steel with flanged edges, and integral orifice ring.

C. Frame: One piece, square steel with die formed venturi orifice, mounting flanges and supports, with baked enamel finish.

D. Fan Wheels: Provide fan wheels of one of the following materials. Wheels shall be keyed and locked to the shaft and directly connected to the motor or provided with V-belt drive.

1. Formed-steel blades riveted to a heavy-gage steel spider bolted to cast-iron hub.
2. Replaceable, cast-aluminum blades fastened to cast-aluminum hub. Factory set pitch angle of blades.
3. Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub. Factory set pitch angle of blades.

E. Drive Assembly: Direct-drive or belt-driven as indicated.

F. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Pulleys: Cast-iron, adjustable-pitch.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
4. Motor and Drive Assembly: Resiliently mounted to the housing.

G. Accessories: Provide the following accessories as indicated:

1. Belt Guards: Expanded metal with reinforced edges.
2. Gravity Shutters: Gravity-type shutters with aluminum blades in steel frames, mounted on discharge side of fan.
3. Backdraft Damper: Multiple blade with offset hinge pin, blades linked.
4. Outlet Damper: Multiple blade with offset hinge pin, blades linked, line voltage motor drive, power open, spring return.
5. Safety Screens: Expanded galvanized metal over inlet, motor, drive; to comply with 29 CFR 1910.
6. Hood: Weather shield, to exclude rain and snow.
7. Controller: Solid-state speed controller.

H. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.5 CIRCULATION FANS

A. General Description: Propeller-type fans less than 6 feet in diameter consisting of fan blades, hub, mounting system, motor, and fan controller.

B. Fan Blades: Aluminum alloy or custom material as scheduled on the drawings.

C. Hub: Cast aluminum alloy.

D. Motor and Frame: High efficiency, brushless DC or EC motor with digital inverter drive.

E. Mounting System: Designed for secure mounting of fan from overhead support structure.

2.6 HVLS FANS

A. General Description: Propeller-type fans 6 feet in diameter and larger consisting of fan blades, hub, mounting system, bevel gear reducer drive, motor, and fan controller.

B. Fan Blades: Aluminum alloy, airfoil design.

C. Hub: Cast aluminum alloy incorporating 1/4” or greater steel safety clips to restrain the hub/airfoil assembly in case of shaft failure.

D. Bevel Gear Reducer: High efficiency, helical gear reducer with a cast iron housing, designed for low noise and long service life with a backlash of less than 20 arc-minutes. Output shaft shall be stainless steel. Gear reducer shall be permanently lubricated and be assembled with double lip seals to prevent contamination or oil leakage.

E. Motor and Frame: 1750 RPM, 208-230/460 VAC, 60 Hz, 3 phase, inverter rated with class F insulation, 40 degrees C Ambient-Continuous. Provide HP as scheduled or as applicable. Motor frame and mount shall be constructed of minimum 3/16” powder-coated steel.

F. Mounting System: Designed for secure mounting of fan from overhead support structure with extension rod. Mount shall be constructed of minimum 3/16” powder-coated steel. Provide minimum 1/4” 7x19 steel safety cable to secure fan assembly to structure.

G. Fan Controller:

1. Auxiliary contacts to shutdown fan upon notification from fire alarm system.
2. Industrial Control Panel constructed per UL 508A and NEC.
3. Factory programmed Variable Frequency Drive (VFD) for soft start and infinite speed control.
4. Size VFD for motor full load amp rating.
5. Provide overload relay for each motor when VFD controls multiple fans.
6. Provide load reactors for 460 VAC multi-fan control.
7. Provide fan on/off/auto switch, speed control potentiometer, safety disconnect and properly sized fuse block.
8. Provide NEMA Type 1 controls enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb, in accordance with manufacturer's written instructions.

B. Support units as described below, using the vibration control devices indicated. Vibration control devices are specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."

1. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.

C. Arrange installation to provide access space around fans for service and maintenance.

D. Provide safety screen where inlet or outlet is exposed.

E. Install extension rod to maintain minimum 3 feet vertical clearance between HVLS fan blades and sprinkler deflectors according to NFPA 13.

3.2 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.3 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping blocking and bracing.
2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify 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 and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
7. Disable automatic temperature control operators.

B. Starting procedures for fans:

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

a. Replace fan and motor pulleys as required to achieve design conditions.
b. Measure and record motor electrical values for 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.

3.4 DEMONSTRATION

A. Demonstration Services: Train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.

2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."

B. Schedule training with at least 7 days' advance notice.

END OF SECTION 233413

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SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of power ventilators:

1. Roof-mounted exhausters
2. Wall-mounted exhausters
3. Ceiling-mounted ventilators
4. Inline centrifugal fans.

1.2 REFERENCE STANDARDS

A. AMCA 99 – Standards Handbook.

B. AMCA 204 – Balance Quality and Vibration Levels for Fans.

C. AMCA 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

D. AMCA 300 – Reverberant Room method for Sound Testing of Fans.

E. AMCA 301 – Certified Ratings Program Product Rating manual for Fan Sound Performance.

F. AMCA 311 – Certified Ratings Program Product Rating Manual for Fan Sound Performance.

G. NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

H. UL 705 – Power Ventilators; Current Edition Including all Revisions.

I. UL 762 – Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition Including all Revisions.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1. Product data for selected models, including specialties, accessories, and the following:

a. Certified fan performance curves with system operating conditions indicated.
b. Certified fan sound power ratings.
c. Motor ratings and electrical characteristics plus motor and fan accessories. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
d. Materials gages and finishes, including color charts.
e. Dampers, including housings, linkages, and operators.

2. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.

3. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
4. Maintenance data for power ventilators, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.4 QUALITY ASSURANCE

A. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.

B. UL Compliance: Fans and fan motors shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."

C. UL Compliance: Fans and components shall be UL listed and labeled.

D. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

E. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

F. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.5 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

1.6 SPARE PARTS

A. Furnish one additional complete set of belts for each belt-driven fan.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.8 FIELD CONDITIONS

A. Permanent fans may not be used for ventilation during construction.

B. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Centrifugal Roof Ventilators:

a. Accurex.
b. Acme Engrg. & Mfg. Corp.

c. Cook (Loren) Co.
d. Greenheck Fan Corp.
e. Hartzell Fan, Inc.
f. PennBarry.
g. RuppAir Management Systems
h. Twin City Fan Company

2. Axial Roof Ventilators:

a. Acme Engrg. & Mfg. Corp.
b. Carnes Company, Inc.
c. Cook (Loren) Co.
d. Greenheck Fan Corp.
e. Hartzell Fan, Inc.
f. PennBarry.
g. RuppAir Management Systems.
h. Twin City Fan Company

3. Upblast Propeller Roof Exhaust Fans:

a. Acme Engrg. & Mfg. Corp.
b. Carnes Company, Inc.
c. Cook (Loren) Co.
d. Greenheck Fan Corp.
e. Hartzell Fan, Inc.
f. PennBarry.
g. RuppAir Management Systems.
h. Twin City Fan Company

4. Ceiling-Mounted Ventilators:

a. Acme Engrg. & Mfg. Corp.
b. Broan-NuTone
c. Carnes Company, Inc.
d. Cook (Loren) Co.
e. Dayton
f. Greenheck Fan Corp.
g. Panasonic
h. PennBarry.
i. RuppAir Management Systems.
j. Twin City Fan Company

5. Inline Centrifugal Fans

a. Acme Engrg. & Mfg. Corp.
b. Carnes Company, Inc.
c. Cook (Loren) Co.
d. Greenheck Fan Corp.
e. PennBarry.
f. RuppAir Management Systems.
g. Twin City Fan Company

2.2 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required:

1. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

2.3 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished; with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210.

D. Sound Ratings: Comply with AMCA 301. Test fans in accordance with AMCA Standard 300.

E. Fabrication: Comply with AMCA 99.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor: 1.4.

G. Belts: Oil-resistant, nonsparking, and nonstatic.

1. Fans used for smoke control applications shall have 1.5 times the number of belts required for the design duty with a minimum of two belts.

H. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.

I. Shaft Bearings: Provide type indicated, having a median life "Rating Life" (AFBMA L(50)) of 200,000, calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.

J. Hazardous Duty: Provide fans with spark resistant construction and explosion proof motor where specified in the schedule.

K. Factory Finish: The following finishes are required:

1. Sheet Metal Parts: Prime coating prior to final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.4 CENTRIFUGAL ROOF VENTILATORS

A. General Description: Belt-driven or direct-drive as indicated, centrifugal consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Up-blast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
2. Provide quick release latches to facilitate removal of scroll housing for access into the motor compartment.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Pulleys: Cast-iron, adjustable-pitch.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
4. Fan and motor isolated from exhaust air stream.

E. Accessories: Provide the following items as indicated:

1. Disconnect Switch: Non-fusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.
2. Bird Screens: Maximum 1/2-inch mesh, 16-gage, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base, factory set to close when fan stops.
4. Dampers: Motor-operated, parallel-blade, volume control dampers mounted in curb base.

a. Blades: Die-formed sheet aluminum.
b. Frame: Extruded aluminum, with waterproof, felt blade seals.
c. Linkage: Nonferrous metals, connecting blades to counter weight or operator.
d. Operators: Manufacturer's standard electric motor.
e. Operators: Manufacturer's standard pneumatic motor.

F. Roof Curbs: Refer to Section “Hangers and Supports for HVAC” for pre-engineered roof equipment supports .

2.5 CEILING-MOUNTED VENTILATORS

A. General Description: Centrifugal fan designed for installation in ceiling, wall, or concealed inline applications.

B. Housing: Galvanized steel lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Stainless steel, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Remote Fan Speed Control: Solid state, capable of controlling fan speed from full speed to approximately half speed.

G. Accessories: Manufacturer's standard roof jack, wall cap, and transition fittings as indicated.

2.6 INLINE CENTRIFUGAL FANS

A. Fan Unit: Inline, belt or direct driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

B. Housing: Galvanized steel or split, spun-aluminum housing, with straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Wheel: Aluminum, forward curved, backward inclined or airfoil blades welded to aluminum hub.

D. Direct-Drive Units: Motor encased in housing out of air stream, factory-wired to disconnect located on outside of fan housing.

E. Belt-Drive 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. Provide self-aligning pre-lubricated ball bearings.

F. Accessories: Provide the following accessories as indicated:

1. Volume Control Damper: Manual operated with quadrant lock, located in fan outlet.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: Expanded metal in removable frame.
4. Speed Control: Variable speed switch with on-off control and speed control for 100 to 50 percent of fan air delivery.

2.7 MOTORS

A. Motors: Refer to Section “Common Motor Requirements for HVAC Equipment” for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb, in accordance with manufacturer's written instructions.

B. Secure roof-mounted fans to pre-engineered roof equipment supports in accordance with the requirements specified in Section “Hangers and Supports for HVAC Piping and Equipment.”

C. Ceiling Units: Suspend units from structural steel support frame using steel wire or metal straps.

D. Install vibration isolation for equipment as specified in Division 23 Section “Vibration Isolation for HVAC Piping and Equipment.”

E. Arrange installation to provide access space around fans for service and maintenance.

3.2 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.3 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping blocking and bracing.
2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify 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 bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
7. Disable automatic temperature control operators.

B. Starting procedures for fans:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

    a. Replace fan and motor pulleys as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.
3. Shut unit down and reconnect automatic temperature control operators.
4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.4 DEMONSTRATION

A. Demonstration Services: Train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."

B. Schedule training with at least 7 days' advance notice.

END OF SECTION 233423

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SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this Section.

B. Types of outlets and inlets required for project include the following:

1. Ceiling air diffusers.
2. Registers and grilles.
3. Drop box diffusers.
4. Linear slot diffusers.
5. Louvers.

C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this Section.

D. Refer to other Division 23 sections for balancing of air outlets and inlets; not work of this Section.

1.2 RELATED REQUIREMENTS

A. 230548 – Seismic Controls for Mechanical Systems, for seismic controls.

1.3 QUALITY ASSURANCE

A. Codes and Standards:

1. AHRI Compliance: Test and rate air outlets and inlets in accordance with AHRI 650 "Standard for Air Outlets and Inlets".
2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
5. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".
6. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
7. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows. Indicate selections on data.
4. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.
5. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

PART 2 - PRODUCTS AND MATERIALS

2.1 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 provided with accessories as required for a 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 scheduled on the drawings.

E. Manufacturers: Subject to compliance with requirements, provide diffusers of one of the following:

1. Price Industries, Inc.
2. Titus HVAC
3. Carnes Co.
4. Krueger Mfg. Co.
5. Metalaire; Metal Industries, Inc.
6. Nailor Industries, Inc.
7. Tuttle & Bailey; Div. of Air Systems Components, Inc.

2.2 REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a 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 and listed in manufacturer's current data.

C. Ceiling Compatibility: Provide registers and grilles 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 register and grille.

D. 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.

E. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.

F. Manufacturers: Subject to compliance with requirements, provide registers and grilles of one of the following:

1. Price Industries, Inc.
2. Titus HVAC
3. Carnes Co.
4. Krueger Mfg. Co.
5. Metalaire; Metal Industries, Inc.
6. Nailor Industries, Inc.
7. Tuttle & Bailey; Div. of Air Systems Components, Inc.

2.3 LINEAR SLOT DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard linear slot diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

B. Performance: Provide linear slot 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. Compatibility: Provide linear slot diffusers with border styles that are compatible with adjacent ceiling or wall systems, and that are specifically manufactured to fit into ceiling or wall with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling and wall systems which will contain each type of linear slot diffuser.

D. Linear Slot Diffusers: Slot diffusers shall be standard one-piece lengths up to 6-feet and shall be furnished in multiple sections greater than 6-feet. Provide straight and curved sections as required to accommodate layout shown on the drawings. Multiple sections shall be joined together end-to-end with alignment pins to form a continuous slot appearance. All alignment components shall be provided by the manufacturer. Where specified on the drawings, plenums shall be manufactured by the slot diffuser manufacturer. Plenums shall be internally insulated, by the manufacturer, with minimum ¼” thick, closed-cell insulation. Insulation shall not be made of fibrous material.

E. Types: Provide linear slot diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

F. Manufacturers

1. Carnes Co.
2. Krueger Mfg. Co.
3. Metalaire; Metal Industries, Inc.
4. Nailor Industries, Inc.
5. Price Industries, Inc.
6. Titus HVAC
7. Tuttle & Bailey; Div. of Air Systems Components, Inc.

2.4 DROP BOX DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard drop box diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

B. Performance: Provide drop box diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

C. Construction: Drop box diffusers shall be minimum 22 gauge galvanized steel construction, factory assembled and welded, and provided with standard duct connections and mounting brackets for field installation. Diffusers shall have double deflection grilles or drum louvers that are individually adjustable to customize horizontal and vertical throws and factory installed air diverters or turning vanes.

D. Diffusers shall be insulated with 1” thick, 1.5 lb duct liner insulation.

E. Diffusers shall have be factory primed and painted, color as selected by the Architect.

F. Manufacturers: Subject to compliance with requirements, provide registers and grilles of one of the following:

1. AES Industries
2. Carnes Co.
3. EP Custom Products
4. Kees
5. Plenums Inc.
6. Ruskin

2.5 LOUVERS

A. General: Except as otherwise indicated, provide manufacturer's standard louvers as scheduled or indicated on the drawings; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

B. Performance: Provide louvers that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with louver schedule.

1. Structural Performance: Louvers shall withstand the effects of gravity loads and wind and/or seismic loads as defined in the applicable building code for the installed location 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.
2. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions to meet seismic requirements specified on the drawings or in Division 23 Section 230548 “Seismic Controls for Mechanical Systems”. Component importance factor shall be [1.0][1.5].

C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.

D. Materials: Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners.

E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

F. Louver Supports: Louver design shall limit span between visible mullions to 10' and shall incorporate structural supports required to withstand a wind load of 20 lbs. per sq. ft.

G. Intermediate Blade Supports: Where needed blade supports shall be provided by louver manufacturer on the rear of blade only.

H. Louver Blank-Off Panels: Blank off any unused portions of louver with lined galvanized sheet metal panels and seal airtight. Back of panels shall be insulated with 1” thick, 3 lb. density duct liner.

I. Manufacturers: Subject to compliance with requirements, provide louvers of one of the following:

1. Carnes Co.; Div. of Wehr Corp.
2. Greenheck
3. Nailor Industries, Inc.
4. Ruskin Mfg. Co.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.

C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor’s option, a flexible elbow assembly as specified in Division 23 section “Metal Ducts”.

D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

E. Linear Slot Diffuser Installation:

1. For installations in a hard ceiling, install diffuser prior to installation of drywall. Use manufacturer’s hard ceiling clips for mounting to ceiling framing. Screws through face of diffuser are not acceptable.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

END OF SECTION 233713

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SECTION 234100 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of air cleaning work required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Types of air cleaning equipment specified in this Section include the following:

1. Air Filters

    a. Cleanable (washable)
    b. Replaceable (throwaway) panel and pleated

2. Filter Holding Systems

    a. Front and Rear Access Filter Frames
    b. Side Servicing Housings

3. Filter Gages

C. Filter sections of packaged air handling units are work of this section.

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. NFPA Compliance: Comply with applicable portions of NFPA 90A and 90B, and NEC pertaining to installation of air filters and associated electric wiring and equipment.
2. UL Compliance: Comply with UL Standards pertaining to safety performance of air filter units.
3. ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing, and for recording and calculating air flow rates.
4. AHRI Compliance: Comply with provisions of AHRI Standard 850 pertaining to test and performance of air filter units.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data including, dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, fire classification, and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for filter rack assemblies indicating dimensions, materials, and methods of assembly of components.

C. Samples: Submit one sample filter cartridge for each type of filter required; in accordance with requirements of Division 1.

D. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air filter units. Submit manufacturer's ladder-type wiring diagram for control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

E. Maintenance Data: Submit maintenance data and spare parts lists for each type of filter and rack required. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.4 SPARE PARTS

A. Provide one complete spare set of filters of each type required for each air handling system. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work.

B. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide air cleaning equipment of one of the following:

1. Air Filters

a. AAF International.
b. Air Filter Inc.
c. Bioclimatic Air Systems
d. Columbus Industries, Inc..
e. Camfil Farr.
f. Filtration Group
g. Koch Filter Corp.
h. Research Products Corp.

2.2 AIR FILTERS

A. Side Servicing Housings: Provide factory-assembled side servicing housings with flanges for insertion into ductwork system as indicated. Construct of 16-ga galvanized steel. Provide integral pre-filter tracks to accommodate 2" throw-away or cleanable filters. Provide access doors with continuous gasketing on perimeter and positive locking devices. Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass. Arrange so filter cartridge can be loaded from either access door.

B. Leak-test housing by pressurizing to 3" w.g. and soap-bubble test housing joints, door seals, and filter sealing edges. Provide crank-operated spring-loaded filter-sealing mechanism with limit stop, so geared that total pressure of 600 lbs. will be exerted on each filter. Design clamping frame to provide continuous knife-edge seal for all four edges of each individual filter.

2.3 FILTER GAGES

A. Provide diaphram-type filter gage for each filter bank, with dial and pointer, graduated to read from 0 to 2" w.g.

B. Provide manometer-type filter gage for each filter bank, with logarithmic curve tube gage, with integral leveling gage, graduated to read from 0 to 3" w.g.

1. Provide pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer’s instructions and comply with installation requirements as specified elsewhere in these specifications pertaining to air filters housing/casings, and associated supporting devices.

B. Install air filters and holding devices of types indicated, and where shown; in accordance with air filter manufacturer's written instructions and with recognized industry practices; to ensure that filters comply with requirements and serve intended purposes.

C. Locate each filter unit accurately in position indicated, in relation to other work. Position unit with sufficient clearance for normal service and maintenance. Anchor filter holding frames securely to substrate.

D. Coordinate with other work including ductwork and air handling unit work, as necessary to interface installation of filters properly with other work.

E. Install filters in proper position to prevent passage of unfiltered air.

F. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 16 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
2. Install air filter gage pressure tips upstream and downstream of filters to indicate air pressure drop through air filter. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level inclined gages if any, for proper readings.

END OF SECTION 234100

SECTION 238126 - SPLIT SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1. Indoor evaporator fan coil units.
2. Outdoor condenser units.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division1 Specification Sections apply to this Section.

B. Section 221300 – Plumbing Piping for condensate drains.

C. Section 230500 – Common Work Results for HVAC for concrete, reinforcement, and formwork requirements.

D. Section 230529 – Hangers and Supports for HVAC Piping and Equipment.

E. Section 230550 – Vibration Isolation for HVAC Piping and Equipment.

F. Section 230593 – Testing, Adjusting, and Balancing for HVAC for unit balancing.

G. Section 230900 – Instrumentation and Control for HVAC: for thermostats, humidistats, timeclocks and for HVAC for installing external control components.

H. Section 232300 – Refrigerant Piping for refrigerant piping connecting the system.

I. Section 233113 – Metal Ducts for ductwork connecting to units.

J. Section 262717 – Equipment Wiring: Electrical characteristics and wiring connections.

K. Section 233300 – Air Duct Accessories.

1.3 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; most current edition.

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; most current edition.

C. NFPA 70 – National Electric Code.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, type of refrigerant used, refrigerant

pipe sizing, and electrical characteristics. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.

B. Shop Drawings: Provide drawings that indicate size, profile, dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, accessories, and trouble-shooting guide.

1. Include manufacturer’s recommended maintenance schedule of units installed in a seacoast application, within 5 miles of the coast.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

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. Units shall be designed to operate with HCFC-free refrigerants.

D. Units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 and bear the Listed Mark.

E. The system components shall be rated in accordance with AHRI Standard 210/240, Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.

1.6 FLAMMABLE REFRIGERANTS

A. Equipment with refrigeration systems using Group A2L refrigerants shall meet all requirements of ASHRAE Std 15 and this section.

B. Listing and Installation Requirements:

1. Listed in accordance with UL 484 or UL 60335-2-40/CSA C22.2 No. 60335-2-40.
2. The nameplate shall include a symbol indicating that a flammable refrigerant is used, as specified by the product listing.
3. A label indicating a flammable refrigerant is used shall be placed adjacent to service ports and other locations where service involving components containing refrigerant is performed, as specified by the product listing.

C. Refrigeration systems shall have an integral refrigerant detection system that meets the following requirements as documented in ASHRAE Std 15:

1. Utilize a set point, nonadjustable in the field, to generate an output signal to initiate mitigation actions.
2. Field recalibration of refrigerant detection system shall not be permitted.

3. Be capable of detecting the presence of a specified refrigerant corresponding to the refrigerant designation of the refrigerant contained in the refrigeration system.
4. Have access for replacement of refrigerant detection system components.
5. Have self-diagnostics to determine operational status of the sensing element.
6. Energize air circulation fans of the equipment upon failure of a self-diagnostic check.
7. Generate an output signal in not more than 30 seconds when exposed to a refrigerant concentration of 25% LFL (+0%, -1%).

D. Manufacturer’s refrigeration mitigation action shall be completed in not more than 15 seconds after the initiation of the output signal of the equipment’s integral refrigerant detection system and shall be maintained for at least 5 minutes after the output signal has reset.

1.7 COORDINATION

A. Coordinate layout and installation of units and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations with roof construction and actual equipment provided. Roof specialties are specified in Division 7 Sections. Concrete, reinforcement and formwork are specified in Division 3 Sections.

1.8 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturers standard, but not less than 1 year after date of Substantial Completion.

1.9 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Daikin US Corporation.
2. LG.
3. Mitsubishi Electric & Electronics USA, Inc.
4. Trane.
5. York.

2.2 INDOOR UNITS

A. General: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.

B. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.

C. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.

D. Motor: Comply with NEMA designation temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

E. Air Filters: Washable type for wall-mount units, minimum 1 inch thick throwaway type for all other units, unless scheduled otherwise.

F. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

G. Electric Heating Coil: Nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

H. Gas Furnace: Atmospheric burner, gas valve with 100 percent safety gas shut-off; pressure regulation, safety pilot, manual set (On-Off), pilot filtration, and automatic electric valve.

1. Burner Safety Controls:

a. Thermocouple Sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
b. Flame Rollout Switch: Installed on burner box and prevents operation.
c. Vent Safety Shutoff Sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
d. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic reset.

I. Controls: Unit-mounted panel with contactors, control transformer with circuit breaker, solid-state temperature- and humidity-control modules, time-delay relay, and thermostat.

J. Where scheduled on the drawings, provide condensate lift pump with a built-in safety cutoff switch and integral check valve on discharge.

2.3 OUTDOOR UNITS

A. General: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

B. Air-Cooled Condenser:

1. General: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
2. Casing: Steel, baked enamel finish, 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.
3. Compressor: Hermetic scroll-type with resilient suspension system, oil strainer, crankcase heater, start capacitor, relay, contactor, and internal motor overload protection.
4. Accessories:

a. Liquid line filter drier.
b. High pressure switch (manual reset).
c. Low pressure switch (automatic reset).
d. Service valve with gauge ports.
e. Thermometer well in liquid line.
f. Low-ambient kit where scheduled.
g. Compressor short-cycling controls.
h. Reversing valve for heat pump units.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine area for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Verify that flooring or ceiling system is ready to receive work and opening dimensions are as indicated on Shop Drawings.

C. Verify that power supply is available and of the correct characteristics.

3.2 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Install unit level and plumb.

C. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

D. Install roof-mounted, compressor-condenser components on roof equipment supports with vibration isolation. Anchor units to supports with removable, cadmium-plated fasteners.

E. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base or polyethylene mounting base with vibration isolators.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.

B. Route unit condensate drain to location shown on the drawings or, if not shown, to nearest indirect waste connection. Provide trap at drain pan, minimum of 1 inch deeper than fan pressure in inches of water, and install cleanouts at changes in direction. Size condensate drain piping in accordance with local code and the following:

Piping Length	Size
Less than 10 feet	Same size as unit connection
More than 10 feet	One pipe size larger than unit connection

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect ductwork to units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories." Provide transitions to exactly match unit duct connection size.

3.4 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust fan for required airflow in accordance with Section “Testing, Adjusting and Balancing.” Tighten belts as required for proper operation.

B. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.

C. Adjust damper linkages for proper damper operation.

D. Set initial temperature and humidity set points.

E. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.5 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects. Verify vibration isolation and flexible connections are installed correctly.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Set outside-air and return-air mixing dampers to minimum outside-air setting.
7. Comb coil fins for parallel orientation.
8. Install new filters at completion of installation and prior to testing, adjusting, and balancing. Do not operate air handling unit without pre-filters installed.
9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
10. Disable automatic temperature control operators.

B. Start-Up Services: Start-up units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

a. Replace fan and motor pulleys as required to achieve design conditions.
b. Measure and record motor electrical values for 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 system testing, adjusting, and balancing.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.7 DEMONSTRATION

1. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.
2. Content: Training shall include but not be limited to:

a. Overview of the system and/or equipment as it relates to the facility as a whole.
b. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

c. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

3. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.
4. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 238126

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SECTION 238149 - ROOFTOP HEAT PUMP UNITS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Section includes package rooftop heating and cooling heat pump units.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories; and installation and start-up instructions. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.

B. Shop Drawings:

1. Submit manufacturer's assembly-type shop drawings indicating dimensions, required clearances, and methods of assembly of components
2. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.

C. Wiring Diagrams: Submit wiring diagrams detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling heat pump units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Operation and Maintenance Data: Submit maintenance data and parts list for each heat pump unit, including "trouble-shooting" maintenance guide, servicing guide and preventative maintenance schedule and procedures. Include this data in maintenance manual; in accordance with requirements of Division 1.

1.3 QUALITY ASSURANCE

A. Codes and Standards:

1. Testing and rating of rooftop units of 135,000 btu/hr capacity or over shall be in accordance with AHRI 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment".
2. Testing and rating of rooftop units under 135,000 btu/hr capacity shall be in accordance with AHRI 210 "Standard for Unitary Air-Conditioning Equipment", and provide Certified Rating Seal. Sound testing and rating of units shall be in accordance with AHRI 270 "Standard for Sound Rating of Outdoor Unitary Equipment". Units shall bear Certified Rating Seal.
3. Refrigerating system construction of rooftop units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
4. Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90.1-2004 "Energy Standard For Buildings Except Low-Rise Residential Buildings".
5. Rooftop units shall be listed by UL and have UL label as a unit.
6. Rooftop units shall be designed, manufactured, and tested in accordance with UL requirements.

1.1 FLAMMABLE REFRIGERANTS

A. Equipment with refrigeration systems using Group A2L refrigerants shall meet all requirements of ASHRAE 15 and this section.

B. Listing and Installation Requirements:

1. Listed in accordance with UL 484 or UL 60335-2-40/CSA C22.2 No. 60335-2-40.
2. The nameplate shall include a symbol indicating that a flammable refrigerant is used, as specified by the product listing.
3. A label indicating a flammable refrigerant is used shall be placed adjacent to service ports and other locations where service involving components containing refrigerant is performed, as specified by the product listing.

C. Refrigeration systems shall have an integral refrigerant detection system that meets the following requirements as documented in ASHRAE 15:

1. Utilize a set point, nonadjustable in the field, to generate an output signal to initiate mitigation actions.
2. Field recalibration of refrigerant detection system shall not be permitted.
3. Be capable of detecting the presence of a specified refrigerant corresponding to the refrigerant designation of the refrigerant contained in the refrigeration system.
4. Have access for replacement of refrigerant detection system components.
5. Have self-diagnostics to determine operational status of the sensing element.
6. Energize air circulation fans of the equipment upon failure of a self-diagnostic check.
7. Generate an output signal in not more than 30 seconds when exposed to a refrigerant concentration of 25% LFL (+0%, -1%).

D. Manufacturer’s refrigeration mitigation action shall be completed in not more than 15 seconds after the initiation of the output signal of the equipment’s integral refrigerant detection system and shall be maintained for at least 5 minutes after the output signal has reset.

1.4 WARRANTY

A. Provide warranty on units as required by spec section 230010.

PART 2 - PRODUCTS AND MATERIALS

2.1 ROOFTOP HEAT PUMP UNITS LESS THAN 20 TONS

A. Manufacturers: Subject to compliance with requirements, provide rooftop heat pump units of one of the following:

1. Aaon, Inc.
2. Daikin
3. Carrier
4. Captive Aire
5. Lennox
6. Trane

B. General Description: Units shall be factory-assembled and tested, designed for roof installation, and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers. Capacities and electrical characteristics are scheduled on the Drawings.

C. Casing: Manufacturer's standard casing construction, having corrosion protection coating, and exterior finish. Casings shall have removable panels or access doors for inspection and access to internal parts, a minimum of 1/2" thick thermal insulation, knockouts for electrical and piping connections and an exterior condensate drain connection and lifting lugs.

D. Roof Curbs: [Provide manufacturer's standard construction, insulated and having corrosive protective coating, complete with factory-installed wood nailer and drain nipple. Construction shall be in accordance with NRCA Standards.][Refer to Section “Vibration Isolation for HVAC Piping and Equipment” for vibration isolation curbs.] Curb shall be sloped to match roof structure to enable the rooftop unit to be installed level.

E. Evaporator Fans: Forward-curved, centrifugal, belt-driven fans with adjustable sheaves or direct-driven fans; and permanently lubricated motor bearings.

F. Condenser Fans: Propeller-type, direct-driven fans with permanently lubricated bearings.

G. Motors: Refer to Section “Common Motor Requirements for HVAC Equipment” for requirements.

H. Coils:

1. General: Aluminum plate fin and seamless copper tube type. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing. Coils shall be mounted in the coil casing with same end connections accessible for service. Coils shall be removable from the unit through the roof or through the piping enclosure. Coil section shall be completely insulated.
2. Refrigerant Cooling Coils: Coils shall have an equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant. Coils shall be designed for 300 psig working pressure and pressure tested at 450 psig., then cleaned, dehydrated, and sealed with a holding charge of refrigerant.
3. Hot Gas Reheat Coil: Provide hot gas reheat coil with staged or modulating control for reheat during dehumidification operation. Hot gas reheat coil shall maintain space temperature when unit is operating in the dehumidification mode. Refer to sequence of operations.

I. Compressors: Provide serviceable, semi-hermetic, or fully hermetic modulating staged compressors, complete with integral vibration isolators and crankcase heaters.

1. For heat pump units, provide reversing valve, suction line accumulator, flow control check valve, and solid state defrost control utilizing thermistors.

J. Condensate Drain Pan: Provide stainless steel condensate pan sloped to drain connection.

K. Safety Controls: Provide manual reset type for:

1. Low pressure cutout;
2. High pressure cutout;
3. Compressor motor overload protection.

L. Electric Heat Sections: Provide electric heat coils, of manufacturer's standard construction, factory-wired for single point wiring connection, complete with over-current and over-heat protection devices.

M. Dampers:

1. General: Dampers and their operators shall comply with performance requirements specified in Division 23 Section “Instrumentation and Control for HVAC.”
2. Outdoor Air Damper:

    a. Provide outside air damper constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven.
    b. Refer to schedules on the drawings for capacity and control method of the outdoor air damper of each unit.

N. Economizer Control:

1. Provide economizer system complete with return and outside air dampers, outside air filter, fully modulating electric control system with dry bulb or enthalpy economizer control as scheduled on the drawings, and adjustable mixed-air thermostat.
2. System shall have 100 percent outside air capability.
3. Provide automatic changeover through adjustable control device.

O. Relief Control:

1. Power Exhaust Fan: Direct drive, propeller type designed for low tip speed. Motors shall be open drip-proof with internal motor protection and permanently lubricated ball bearings.
2. Damper: Include a relief damper with control type as scheduled on the drawings.

P. Filters Section: Provide 1” thick for units 7-1/2 tons and smaller, 2" thick for units larger than 7-1/2 tons, throwaway pleated filters, Farr 30/30 or approved equal, in filter rack, with maximum face velocity of 400 fpm. Filters shall have minimum MERV rating per ASHRAE 52.2 of MERV 7.

Q. Electrical: Units shall have a 115 VAC convenience outlet, separately fused, for unit service. Unit power connection shall be either through unit cabinet or within roof curb perimeter. Rooftop units shall be designed to meet the minimum short-circuit withstand rating specified on the drawings.

R. Accessories: Units shall include the following accessories:

1. Low ambient control head pressure control, designed to operate at temperatures down to 25 deg F, where indicated on schedule.
2. Thermostat: Assembly shall provide for staged heating and cooling with manual or automatic changeover on standard subbase. Refer to controls specification, Section 17110.
3. Provide guards to protect the condenser coil from hail or other damage.
4. Provide birdscreens on outside air inlets to unit.

2.2 ROOFTOP HEAT PUMP UNITS 20 TONS AND LARGER

A. Manufacturers: Subject to compliance with requirements, provide rooftop units of one of the following:

1. Aaon, Inc.
2. Daikin
3. Carrier
4. Lennox
5. Trane

B. General Description: Rooftop unit shall be factory-assembled and tested, designed for roof installation and, consisting of compressors, condensers, evaporator coils, condenser and

evaporator fans, refrigeration and temperature controls, filters, and dampers. Capacities and electrical characteristics are scheduled on the Drawings.

C. Casing shall be manufacturer's standard casing construction, having corrosion protection coating, and exterior finish. Casings shall have removable panels or access doors for inspection and access to internal parts, a minimum of 1" thick thermal insulation, knockouts for electrical and piping connections, and an exterior condensate drain connection, and lifting lugs.

D. Roof Curbs: [Provide manufacturer's standard construction, insulated and having corrosive protective coating, complete with factory-installed wood nailer and drain nipple. Construction shall be in accordance with NRCA Standards.][Refer to Section “Vibration Isolation for HVAC Piping and Equipment” for vibration isolation curbs.] Curb shall be sloped to match roof structure to enable the rooftop unit to be installed level.

1. Overall Roof Curb Height: Minimum 12 inches for roofs with no insulation, 15” for roofs with insulation or as scheduled on the drawings.

E. Evaporator Fans: Forward-curved, centrifugal, belt-driven fans with adjustable sheaves; and permanently lubricated motor bearings.

F. Condenser Fans: Propeller-type, direct-driven fans with permanently lubricated bearings.

G. Motors: Refer to Section “Common Motor Requirements for HVAC Equipment” for requirements.

H. Coils:

1. General: Aluminum plate fin and seamless copper tube type. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing. Coils shall be mounted in the coil casing with same end connections accessible for service. Coils shall be removable from the unit through the roof or through the piping enclosure. Coil section shall be completely insulated.
2. Continuous tube type, and proof (300 psig) and leak (200 psig) tested with air pressure under water.
3. Refrigerant Cooling Coils: Coils shall have an equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of refrigerant. Provide 1 inch factory installed flexible elastomeric insulation around the suction and liquid lines not directly located above a condensate drain pan. If any piping is exposed to sunlight, provide UV protective coating.
4. Hot Gas Reheat Coil: Provide hot gas reheat coil with staged or modulating control for reheat during dehumidification operation. Hot gas reheat coil shall maintain space temperature when unit is operating in the dehumidification mode. Refer to sequence of operations.

I. Compressors: Provide serviceable, semi-hermetic, or hermetic modulating staged compressors with integral vibration isolators, and crankcase heaters which de-energize during compressor operation. Units shall also have:

1. Cylinder unloaders for capacity control, with minimum steps as scheduled.
2. For heat pump units, provide reversing valve, suction line accumulator, flow control check valve, and solid state defrost control utilizing thermistors.
3. Thermal expansion valves, filter dryers, sight glasses, compressor service valves, liquid line service valves; minimum of 2 refrigerant circuits for units having 2 or more compressors; and fan-cycling control for low ambient control to 25 deg F (2 deg C).

J. Safety Controls: Provide the following:

1. Low pressure cutout, manual reset;
2. High pressure cutout, manual reset;
3. Compressor motor overload protection, manual reset;
4. Anti-recycling timing device;
5. Adjustable low-ambient lockout;
6. Oil pressure switch.

K. Electric Heat Sections: Provide manufacturer's standard construction electric heat coils, factory-wire for single point wiring connection, complete with over-current and over-heat protection devices.

L. Dampers:

1. General: Dampers and their operators shall comply with performance requirements specified in Division 23 Section “Instrumentation and Control for HVAC.”
2. Outdoor Air Damper:

   a. Provide outside air damper constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven.
   b. Refer to schedules on the drawings for capacity and control method of the outdoor air damper of each unit.

M. Economizer Control:

1. Provide economizer system complete with return and outside air dampers, outside air filter, fully modulating electric control system with dry bulb or enthalpy economizer control as scheduled on the drawings, and adjustable mixed-air thermostat.
2. System shall have 100 percent outside air capability.
3. Provide automatic changeover through adjustable control device.

N. Relief Control:

1. Power Exhaust Fan: Direct drive, propeller type designed for low tip speed. Motors shall be open drip-proof with internal motor protection and permanently lubricated ball bearings.
2. Damper: Include a relief damper with control type as scheduled on the drawings.

O. Filters Section: 2" thick throwaway pleated filters, Farr 30/30 or approved equal, in filter rack, with maximum face velocity of 400 fpm. Filters shall have MERV rating per ASHRAE 52.2 of MERV 7.

P. Variable Air Volume Control: Provide variable frequency drive to modulate fan to meet specified sequence of operation. Refer to Division 23 Section “Variable Frequency Drives”.

Q. Electrical: Units shall have a 115 VAC convenience outlet, separately fused, for unit service. Unit power connection shall be either through unit cabinet or within roof curb perimeter. Rooftop units shall be designed to meet the minimum short-circuit withstand rating specified on the drawings.

R. Temperature Control: Provide factory-installed, demand-oriented solid-state control system with minimum of 2 cooling steps and 2 heating steps. Controls shall include solid-state thermostats with dead-band, and sub-base with system and fan switches. Other control features include:

1. Discharge temperature reset capability with space temperature override;

S. Accessories: Units shall include the following accessories:

1. Anti-recycling control to automatically prevent compressor restart for 5-minutes after shutdown.
2. Low ambient control head pressure control, designed to operate at temperatures down to 25 deg F, where indicated on schedule.
3. Thermostat: Assembly shall provide for staged heating and cooling with manual or automatic changeover on standard subbase. Coordinate with control system specification section.
4. Provide guards to protect the condenser coil from hail or other damage.
5. Provide bird screens on outside air inlets to units.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF ROOFTOP HEATING AND COOLING HEAT PUMP UNITS

A. General: Install units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Support: Support units on roof curb.

C. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

D. Ductwork: Refer to Division-23 section "Metal Ducts". Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

E. Piping: Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Condensate Drain Piping: Route condensate drain to nearest roof drain or to location shown on the drawings. Provide trap, minimum of 1" deeper than fan pressure in inches of water, at drain pan connection and install cleanouts at changes in direction (refer to manufacturer’s recommendations for any additional requirements). Size condensate drain piping in accordance with local code and the following:

Piping Length	Size
Less than 10 feet	Same size as unit connection
More than 10 feet	One pipe size larger than unit connection

3.3 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust fan for required airflow in accordance with Section “Testing, Adjusting and Balancing for HVAC.” Tighten belts as required for proper operation.

B. Adjust damper linkages for proper damper operation.

C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.4 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Set outside-air and return-air mixing dampers to minimum outside-air setting.
7. Comb coil fins for parallel orientation.
8. Install clean filters. Do not operate air handling unit without pre-filters installed.
9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
10. Disable automatic temperature control operators.

3.5 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 238149

SECTION 238500 - ELECTRIC HEATING UNITS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES:

A. Horizontal Unit Heaters

B. Commercial Electric Wall Heaters

C. Electric Infrared Radiant Heaters

1.2 SUBMITTALS

A. Submit Shop Drawings as required by Division 1.

B. Submit product data for each type and size of electric heater.

C. Shop Drawings shall indicate volts, phase, watts and all options that are to be provided.

D. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

E. Shop Drawings showing fabrication and installation of electric resistance heating units including plans, elevations, sections, details of components, and attachments to other units of Work.

F. Color Samples: Submit color samples for each type of cabinet finish furnished for Architect selection.

G. Maintenance data for electric resistance heaters to include in the operation and maintenance manual specified in Division 1. Include detailed manufacturer's instructions for cleaning.

1.3 REGULATORY REQUIREMENTS

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing radiant heating panels similar to those indicated for this Project and that have a record of successful in-service performance.

B. Comply with NFPA 70 for components and installation.

C. 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.
3. Fire-resistance-rated, gypsum board assemblies are identical to design designations in listing and labeling agency's product directory.

D. Provide products listed and classified by Underwriter’s Laboratories, Inc. as suitable for purpose intended.

1.4 WARRANTY

A. Provide warranty on units as required by spec section 230010.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Provide electric heaters of voltage, size and capacity as indicated on the Drawings.

B. Electric heaters shall be designed for a single circuit supply and provided with a single integral, factory-mounted power disconnect switch. Heating elements, motor and control circuits shall be subdivided and fused.

C. Elements shall consist of helically coiled nickel chromium alloy resistance wire embedded and completely surrounded in magnesium oxide, enclosed in corrosion resistant sheaths and permanently attached to corrosion resistant steel fins.

D. Motors shall be totally enclosed industrial type, permanently lubricated and equipped with thermal overload protection with automatic reset. Motors shall be mounted on a heavy gauge formed metal bracket. After the thermostat has been satisfied, the fan shall continue to run until residual heat has been dissipated.

E. Electric heaters shall be equipped with an automatic reset thermal cutout which disconnects elements and motors in the event normal operating temperatures are exceeded.

F. Contactors, relays and control transformers shall be factory assembled and wired.

G. Provide 24 volt factory wired thermostat.

2.2 HORIZONTAL UNIT HEATERS

A. Horizontal unit heaters shall be

1. Berko
2. Markel
3. Q Mark
4. Raywall

B. Enclosures shall be fabricated from heavy gauge zinc coated steel, with baked enamel finish. Enclosures shall house all components as called for by this Specification.

C. Air shall be drawn in the back of the heater and discharged through adjustable double deflection louvers on the front.

D. Provide a factory wired, unit mounted thermostat unless the drawings indicate a remote thermostat is required.

2.3 COMMERCIAL ELECTRIC WALL HEATERS

A. Commercial electric wall heaters shall be:

1. Erincraft
2. King Electric
3. Raywall
4. Indeeco
5. Markel

B. Back boxes for wall heaters shall be 20 gauge galvanized steel. Enclosures for surface mounted wall heaters shall be painted with a dark brown enamel finish. Recessed heaters shall be mounted 6” above the finished floor.

C. Grilles shall be steel with dark brown baked enamel finish. Grilles shall be trimmed with an extruded aluminum frame.

D. Controls shall be concealed behind a removable cover.

E. Controls shall be exposed on the front of the unit.

2.4 ELECTRIC INFRARED RADIANT HEATERS

A. Manufacturers:

1. AmbiRad
2. Berko
3. Chromalox
4. King Electric
5. Markel
6. Raywall
7. QMark

B. Heaters shall be U.L. Listed and designed for outdoor mounting and have a U.L. label affixed to the unit. Installation shall meet applicable requirements of the latest edition of the National Electric Code.

C. Enclosures: Painted-steel housing with anodized-aluminum reflector.

1. Finish: Baked-enamel finish in manufacturer’s standard paint color as selected by the Architect.

D. Radiation Pattern: Beam angle of 30, 60 or 90 degree symmetrical, or 60 degree asymmetrical as specified in the heater schedule.

E. Heating elements:

1. Quartz Lamp Heating Elements: Coiled tungsten-wire heating element enclosed in clear quartz tube.
2. Quartz Tube Heating Elements: Nickel-chromium-wire heating element enclosed in quartz tube.
3. Metal-Sheathed Heating Elements: Nickel-chromium-wire heating element embedded in magnesium oxide powder and enclosed in metal sheath. Comply with UL1030.

F. Unit Controls: Provide with the following manufacturer-supplied control devices:

1. Wall Thermostat: Bimetal sensing elements calibrated from 35 to 90 deg F, with contacts suitable for 24-V circuit and with manually operated, snap-acting OFF switch.
2. Control Accessories: Contactors, relays, and control transformers for 24-V control circuit.

G. Mounting Bracket: Provide tilt adjust mounting bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions are acceptable prior to beginning installation.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Locate each unit in the position indicated.

C. Install units with sufficient clearance from adjacent construction, piping, ductwork and other obstructions to allow access for service and maintenance.

D. Support unit heaters from structure.

E. Install flush units tight to the wall. The unit trim shall cover the opening.

3.3 FIELD QUALITY CONTROL

A. Verify operation of each electric heating unit by measuring input voltage and current simultaneously for period of ten minutes of continuous operation.

3.4 DEMONSTRATION

A. Demonstrate location and setting procedures for thermostats and other heating controls.

END OF SECTION 238500

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SECTION 250800 - COMMISSIONING OF BUILDING MANAGEMENT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. See Section 019113 - General Commissioning Requirements for Contractor's commissioning responsibilities and Commissioning Scope of Work, including a list of systems to be commissioned. Comply with requirements of Section 019113.

B. The Commissioning Authority (3PCx) directs and coordinates all commissioning activities as described in Section 019113.

1.02 RELATED REQUIREMENTS

A. Section 019113 - General Commissioning Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 OPERATION AND MAINTENANCE MANUALS

A. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

B. See Section 017800 for additional requirements.

END OF SECTION

SECTION 251300 - INTEGRATED AUTOMATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This division describes the Systems Integration scope of work for the project. This division also coordinates the responsibilities of the Mechanical and Electrical trade contractors pertaining to control products or systems, furnished by each trade that will be integrated by this Division.

B. All labor, material, equipment and software not specifically referred to herein or on the plans, that are required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

1.2 RELATED DOCUMENTS

A. Alarms List Template.

1. An Alarm List shall be created by the SI with the assistance of the Owner as part of the scope of this project.
2. Alarms from the BMS system shall be transmitted to a predetermined hierarchy developed with the owner. The alarm delivery method and list of alarms shall be coordinated with the Owner as part of this scope.

B. Points Matrix and Building Management System (BMS) Architecture Drawing.

1. Points Matrix provided by Division 23 contractor
2. BMS Architecture Drawings provided by owner as part of the construction documents.

C. Sub-system List

1. Non HVAC systems connected to the BMS for the purposes of alarming and trending.
2. Identifies the system, quantity of systems, communication method (I/O or communication protocol) and points needed for integration into the BMS.

D. Section 23 0900 - Direct Digital Control System (DDCS) for HVAC.

1.3 SYSTEM DESCRIPTION

A. The Integrated Automation System (IAS), also described as the BMS, shall be comprised of Network Area Controller(s) (NAC). The NAC shall connect to the owner's local or wide area network, depending on configuration. Field controllers (IDCs) provided by the Division 23 contractor shall connect to the NACs via hard wired connections (preferred) or Ethernet through the owner's local or wide or network. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network.

B. Client has standardized on ASHRAE Standard 135-2010, BACnet/IP and BACnet MS/TP Control System architecture as the preferred communication method for the BMS. Where factory controls or other controls incorporate Modbus RTU or Modbus TCP/IP communication protocols the Division 25 SI shall be capable of integrating these systems into the BMS. The division of work for this project is segmented between Division 23 and Division 25. Division 25 shall be supported by a preselected Systems Integrator (SI). The SI is responsible for coordinating the consistency of the local operator workstation system graphics and coordinating the integration of the local

Division 23 (DDC) system into the global system. The SI shall also oversee control system-specific commissioning/verification procedures to the contractor administered by this Division.

C. All control components such as communication modules, switches, LAN connectors, etc. shall be mounted in cabinets. Control cabinets shall be single door UL enclosures with hinged doors. All cabinets shall be provided with locksets that match.

D. The controls system front end, , shall be based on the Niagara^{N4} Framework - Vykon (or "Niagara^{N4} - Vykon"), a Java-based framework developed by Tridium.

1. The Division 25 contractor shall provide integration between other devices/sub systems that may not be directly part of the HVAC system, as identified in the bid documents and the BMS for the purposes of alarming and trending.

    a. These systems may include but are not be limited to those identified in the Div 23 sub-system matrix.
    b. Where these systems are provided with a BACnet IP, BACnet MS/TP, Modbus TCP/IP, Modbus RTU, or other communication method the device shall be connected directly to a NAC communication port. The wiring installation and termination for this connection shall be provided by the Division 23 contractor.
    c. Where these systems are provided with outputs/inputs the Division 23 contractor shall provide sufficient wiring and IDC(s) for those points necessary to accurately monitor and/or control the system(s) as indicated on the plans and/or in the points matrix, through connections to a NAC
    d. The Division 25 contractor shall be responsible providing assistance to the Division 26 Contractor and/or the device/system provider in programming/set up of all sub system devices connected to the BMS through a NAC to assure the information is transmitted properly to the BMS.

E. The SI shall also coordinate incorporation of the following components, where applicable, into the BMS:

1. Air Compressor, supplied with factory-mounted BACnet IP or Modbus TCP interface. Coordinate with Project MHE integrator.
2. Generator, supplied with factory-mounted BACnet IP or Modbus TCP interface. Coordinate with Division 26.

1.4 SYSTEM INTEGRATION CONTRACTOR QUALIFICATIONS

A. General

1. The System Integrator shall be CBRE|ESI.
2. The Contractor shall directly hire CBRE|ESI for system integration – see paragraph 3.1 Section 23 0900 for scope responsibilities. Following is contact information for CBRE/ESI:

    Andy Henkel
    Program Manager
    CBRE | Enterprise Global Services
    C +1 920-460-5641

1.5 PROJECT SUBMITTALS

A. Four copies of shop drawings of the IAS system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package.

B. Submittal shall include a network cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.

C. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk and on the Network Supervisor (NS) hard drive. Drawings shall be provided as AutoCAD™ version 2006 or later or Visio™ version 2003 or later compatible files. Four copies of the 'as-built' drawings shall be provided in addition to the documents on electronic media or compact disc. Division 23 and 26 contractors shall provide as-builts for their portions of work. Division 25 System Integrator shall be responsible for as-builts pertaining to overall IAS architecture and network diagrams.

1. Division 23 contractor and Division 25 Integrator shall provide drawings in AutoCAD™ version 2006 or later or Visio™ version 2003 or later.

1.6 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

FMCS	Facility Management and Control System
SI	Systems Integrator
ES	Enterprise System
IAS	Integrated Automation System
SCP	Stand Alone Control Panel
DDCS	Direct Digital Control System
BMS	Building Management System
NAC	Network Area Controller
IDC or BC	Interoperable Digital Controller/Building Controller
ASC	Application Specific Controller
PCU	Programmable Control Unit
GUI	Graphical User Interface
WBI	Web Browser Interface
POT	Portable Operator's Terminal
PMI	Power Measurement Interface
DDC	Direct Digital Controls
LAN	Local Area Network
WAN	Wide Area Network
OOT	Object Oriented Technology
PICS	Product Interoperability Compliance Statement
BIBB	BACnet Interoperability Building Blocks

1.7 DIVISION OF WORK

A. The Division 23/DDCS Contractor shall be responsible for all field controllers (IDC: ASC, PCU) - when not provided by packaged/factory controls, control devices, sensing devices, control panels, controller programming, controller programming software, controller input/output wiring, power

wiring (120VAC and other), interlock and safety wiring, controller network wiring, Ethernet LAN wiring as it pertains to NAC drops or other BMS attached devices, controller I/O wiring, wiring between non-HVAC sub systems and the BMS, sub system programming (as may be required), all terminations, BACnet MS/TP communication or other communication wiring to the NACs, installation of all control panels (including the Division 25 control panels), installation of all control devices, installation of all wiring as well as commissioning and point to point checkout as it pertains to components/systems identified under Division 23.

B. The Division 25 System Integrator (SI) shall be responsible for Network Area Controllers (NAC), NAC control panels, software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, setup of schedules, trend logs and alarms, network management, global supervisory control applications, system integration, coordination of the NAC to the local or wide area network as well as commissioning and point to point check as it pertains to deliverables identified under Division 25. The SI will also be responsible for overseeing point to point check out of the Division 23 deliverables in coordination with and support of the Division 23 contractor to include but not limited to the GUI and global control applications.

1.8 WORK INCLUDED

A. Furnish and install the following application software as outlined in this division.

1. User Interface Software
2. Global and supervisory HVAC application software

B. The following will be coordinated with the owner/owner's agent:

1. Provide custom set-up and development of the software to provide the functional and performance requirements specified. Develop system graphics for all specified mechanical and electrical systems, using animated objects to display all system variables and process valves, according to owner's standards.
2. Provide supervisory control strategies for mechanical and electrical systems to permit the global sequence of operations specified herein.
3. The IAS/BMS shall provide global control, alarm detection, scheduling, reporting and information management for the entire facility as it pertains to the HVAC systems and building sub systems identified in this document and construction documents.

1.9 RELATED WORK SPECIFIED ELSEWHERE

A. Division 23, Mechanical:

1. Providing control devices and systems including but not limited to:

a. Interoperable Digital Controllers and programming
b. Sensors, actuators, indicators and interface equipment
c. Control panels, devices and wiring
d. Control device networks
e. Terminations

B. Division 26, Electrical:

1. Providing motor starters and disconnect switches (unless otherwise noted).
2. Power wiring and conduit (unless otherwise noted).
3. Provision, installation and wiring of smoke detectors (unless otherwise noted).

C. Sub-System Device Matrix

D. Points Matrix – Division 23 09 00

1.10 AGENCY AND CODE APPROVALS

A. All products of the IAS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

1. UL-916; Energy Management Systems
2. UL-508A; Industrial Control Panels
3. ULC; UL - Canadian Standards Association
4. FCC, Part 15, Subpart J, Class A Computing Devices

1.11 SOFTWARE LICENSE AGREEMENT

A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

1.12 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.13 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this division with that of other divisions to insure that the Work will be carried out in an orderly fashion. It shall be this System Integrator's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 - MATERIALS

2.1 GENERAL

A. The Integrated Automation System (IAS) shall be comprised of a network of interoperable, stand-alone Network Area Controllers, servers, operator workstations, graphical user interface software, printers, network devices and other devices as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall IAS.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-2010 BACnet technology (preferred) or other communication protocols in one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry

standards including ANSI / ASHRAE™ Standard 135-2010, BACnet to assure interoperability between all system components is required. For each BACnet device, the device supplier shall provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet or MS/TP.

C. All components and controllers supplied under the Division 25 specification shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

F. The system must be capable of converting any point desired by the owner into an SNMP value for broadcast from BMS server out through router into owner WAN for customer's use as they see fit. The values shall be communicated in 15 minute intervals.

G. The system must be capable of integrating BACnet/IP, BACnet MS/TP, Modbus TCP/IP and Modbus MS/TP (RTU) communication architectures into the IAS.

2.3 NETWORKS

A. The Local Area Network (LAN) shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE standard 802.3
2. Cable; 10 Base-T, UTP-8 wire, category 6
3. Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

C. The network shall be provided by the Division 23 or other contractor.

2.4 NETWORK ACCESS

A. Remote Access

1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The owner shall provide a connection to the Internet to enable this access via

high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

B. Server (Provided by Client)

1. Minimum performance requirements:

a. vCPU: 4
b. Mem (GiB): 16
c. SSD Storage: EBS-only
d. Dedicated EBS Bandwidth (Mbps): 750
e. Operating System – Windows Server 2012
f. Processor - Intel® Core (i7 or Xeon) 2.3Ghz or higher
g. Hard Drive –500 GB or larger capacity

2.5 NETWORK AREA CONTROLLER (NAC)

A. The Division 25 Contractor shall supply one or more Network Area Controllers (NAC) as part of this contract. The number of area controllers required is dependent on the type and quantity of devices provided under Divisions 23 and 26. It is the responsibility of the Division 25 contractor to determine the quantity and type of devices.

B. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of BACnet controller data
7. Integration of Modbus controller data

C. The NAC shall be a Vykon JACE-8000

1. The NAC shall have the following minimum specifications:

a. 1000MHz Processor or higher
b. 1GB DDR3 SDRAM or higher
c. Removable micro-SD card with 4GB flash total storage, 2 GB user storage or higher
d. 2 isolated RS-485 ports with selectable bias and termination
e. 2 10/100MB Ethernet ports

2. A single NAC shall be limited to 4,000 data points or 4,000 histories. If additional data points or histories are required a second NAC shall be added.
3. The NAC must be capable of operation over a temperature range of 0 to 55°C
4. The NAC must be capable of withstanding storage temperatures of between 0 and 70°C
5. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

D. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

E. Event Alarm Notification and actions:

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:

    a. Alarm
    b. Return to normal
    c. Fault

4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
5. Provide timed (schedule) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

F. Control equipment and network failures shall be treated as alarms and annunciated.

G. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text
2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

    a. Day of week
    b. Time of day
    c. Recipient

3. Pagers via paging services that initiate a page on receipt of email message
4. Graphic with flashing alarm object(s)
5. Printed message, routed directly to a dedicated alarm printer

H. The following shall be recorded by the NAC for each alarm (at a minimum):

1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

I. Alarm actions may be initiated by user defined programmable objects created for that purpose.

J. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

L. Provide a “query” feature to allow review of specific alarms by user defined parameters.

M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

N. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

O. Data Collection and Storage:

1. The NAC shall have the ability to collect data for any object and store this data for future use.
2. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:

    a. Designating the log as interval or deviation.
    b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
    c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
    d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis. A default 672 (7 days at 15 minute interval) records shall be available at the NAC for each point
    e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

3. All log data shall be stored in a relational database and the data shall be accessed from a standard Web Browser.
4. All log data, when accessed from the Network Supervisor (NS), shall be capable of being manipulated using standard SQL statements.
5. All log data shall be available to the user in the following data formats:

    a. HTML
    b. XML
    c. Plain Text
    d. Comma or tab separated values

6. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
7. The NAC shall have the ability to archive it’s log data to a Network Supervisor on the network. Provide the ability to configure the following archiving properties, at a minimum:

    a. Archive on time of day
    b. Archive on user-defined number of data stores in the log (buffer size)
    c. Archive when log has reached it’s user-defined capacity of data stores
    d. Provide ability to clear logs once archived

P. Audit Log

1. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive the log based on time to the Network Supervisor. For each log entry, provide the following data:

    a. Time and Date
    b. User ID
    c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

Q. DATABASE BACKUP AND STORAGE

1. The NAC shall automatically backup its database to the Network Supervisor. The database shall be backed up based on a user-defined time interval (every 24 hours for this project).
2. Copies of the current database and, at the most recently saved database shall be stored on the Network Supervisor. The age of the most recently saved database is dependent on the user-defined database save interval.
3. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.6 STAND ALONE CONTROL PANELS (SCP)

A. Furnish control panels of code gauge steel with locking doors for mounting all devices as shown. Panels shall conform to NEMA 1 standards, unless otherwise indicated.

B. Control panels shall meet all requirements of UL508A and shall be so certified and supporting documents provided.

C. Panels shall be constructed prior to delivery to site.

D. For each SCP provide a panel size sufficient for 20% growth of the I/O located within a specific SCP as it pertains to Division 25 delivered I/O.

E. All external wiring shall be connected to terminal strips mounted within the panel.

1. Under no circumstances will field wiring be terminated from inputs or outputs direct to the I/O on the controllers. Further, all spare points meeting the 20% requirement will be pre-wired to terminal strips.

F. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels and the identification number of the panel.

G. A complete set of ‘as-built’ control drawings (relating to the controls within that panel) shall be furnished within each control panel.

H. Each panel shall have a pin-hinged door and master keyed lock.

I. Maximum panel depth no more than 9 inches.

J. Each panel shall be capable of proper operation in an ambient environment of 32 to 122 degrees F and 10% to 90% relative humidity

K. Each control panel (SCP) shall be provided with a minimum of one network switch (4 or 5 port) with one port available for local access to entire system from a service laptop if the control device(s) located in the SCP communicate over an IP network.

1. Managed switches, switches larger than five ports or switches utilized for other resources other than those associated with the BmS shall be provided by others.
2. Switches housed in SCPs supporting IDCs or other Division 23 provided BMS supporting devices shall be provided by the Division 23 contractor.

L. Each switch provided by the Division 25 contractor shall terminate on a dedicated port on a building wide LAN/WAN switch provided by others. SCP housed switches shall not be cascaded or daisy chained.

2.7 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Google Chrome™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacturer-specific browsers shall not be acceptable.

B. 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 IAS, shall not be acceptable.

C. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
2. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
3. Storage of the graphical screens shall be in the Network Area Controller (NAC), the Network Supervisor (NS) or both, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
4. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
5. User’s shall have administrator-defined access privileges (provide a minimum of ten user levels). Depending on the access privileges assigned, the user shall be able to perform the following:

    a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

        1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
        2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

    b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
    c. View logs and charts
    d. View and acknowledge alarms
    e. Setup and execute SQL queries on log and archive information

6. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
7. Signing off the system shall allow the ability to produce a hard copy report of the operator's name, time and date. If an operator should not exercise the system for a period of 15 minutes (adjustable), then the system shall automatically log of that user.
8. In addition to producing reports of valid or invalid sign-on and sign-off attempts, the IAS shall store in nonvolatile memory a historical record of a minimum of 300 systems entries, valid and invalid. This information shall only be available to the operator with the highest access level.

9. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.8 NETWORK SUPERVISOR FUNCTIONS AND HARDWARE

A. A Network Supervisor (NS) shall be provided. The NS shall support all Network Area Controllers (NAC) connected to the control LAN.

B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection.

C. It shall be possible to provide access to all Network Area Controllers via a single connection to the Network Supervisor. In this configuration, each Network Area Controller can be accessed from a remote Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the Network Supervisor.

D. The Network Supervisor shall provide the following functions, at a minimum:

1. Global Data Access: The Network Supervisor shall provide complete access to distributed data defined anywhere in the system.
2. Distributed Control: The Network Supervisor shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
3. The Network Supervisor shall include a master clock service for its subsystems and provide time synchronization for all Network Area Controllers (NAC).
4. The Network Supervisor shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
5. The Network Supervisor shall provide scheduling for all Network Area Controllers and their underlying field control devices.
6. The Network Supervisor shall provide demand limiting that operates across all Network Area Controllers. The Network Supervisor must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
7. The Network Supervisor shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.
8. Each Network Area Controller supported by the Network Supervisor shall have the ability to archive its log data, alarm data and database to the Network Supervisor, automatically. Archiving options shall be user-defined including archive time and archive frequency (every 24 hours for this project).
9. The Network Supervisor shall provide central alarm management for all Network Area Controllers supported by the Network Supervisor. Alarm management shall include:

    a. Routing of alarms to display, printer, email and pagers
    b. View and acknowledge alarms
    c. Query alarm logs based on user-defined parameters

10. The Network Supervisor shall provide central management of log data for all Network Area Controllers supported by the Network Supervisor. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:

    a. Viewing and printing log data
    b. Exporting log data to other software applications
    c. Query log data based on user-defined parameters

2.9 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Graphics, as a minimum, shall be provided as follows:

1. Home Screen summary of alarm list, and critical information to include but not limited to: plant tonnage and percent utilization of available capacity, UPS kW usage and percent utilization of available capacity as a minimum.
2. Floor plans for each floor and roof in the building showing all HVAC and major electrical equipment.

    a. Floor plan maps shall show heating and cooling zones throughout the building in a range of colors (minimum 5) that provide a visual display of temperatures relative to their respective setpoints. The colors shall be updated dynamically as zones’ comfort conditions change. Locations of space sensors shall also be shown for each zone. Floor plan humidity’s shall be represented similarly to zone temperatures. Setpoint adjustment and color band displays shall be provided as a tool for user adjustment.

3. Air flow diagram for each fan system.
4. Water flow diagrams for each hot water, chilled water and condenser water system.
5. Logical and intuitive placement of system values in graphics.
6. Individual graphics for each piece of mechanical and electrical equipment.
7. Site floor plan showing local temperature, humidity, dew point and differential pressure points. Temperature to be color coded using thermographic representation of temperature in relationship to setpoint.
8. User selectable windows for adjustment of system parameters.
9. Animated graphics shall be used in coordination with system status.
10. Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. It shall also provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.
11. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one hour period.
12. The system shall provide protection against excessive demand situations during startup periods by automatically introducing time delays between successive start commands to heavy electrical loads.
13. Upon the resumption of power, the IAS 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.
14. System shall have the ability to ramp open or closed any output to allow for non-instantaneous operation of a device.

15. The operator shall have the ability to override the operation of any SCP command.
16. Modifiable tuning parameters, where available and supported as best practice, shall be provided through the GUI.
17. Status of all NACs with regard to CPU usage and general controller health.
18. Status of all IDCs with regard to communication status.
19. Navigation tree shall be available on the left side of the GUI, to easily navigate to specific pieces of equipment, etc.
20. PUE calculation (contingent on the appropriate level on instrumentation).

D. The GUI shall be programmed to provide a separate graphic/display for:

1. Each piece of equipment monitored or controlled including each terminal unit.
2. Each floor and zone controlled.
3. Each schedule.
4. Each trend.
5. Each report.

E. The graphics shall ensure that the operator is always aware of his position within the system as well as how to easily progress through the graphical hierarchy to select any desired graphic or other source of information.

F. Graphics page layout shall take into consideration future growth of the system and plan accordingly. The SI shall create a GUI which allows for the inclusion of additional statuses and values without requiring major reconstruction of the page layout. The intent is to allow the user who has become acquainted with navigating the GUI to maintain the learned navigation as additional points/systems are added to the BMS.

G. All graphics shall be reviewed by the Engineer and owner at major milestones - 75% and 100% BMS and construction schedule. Contractor shall provide a licensed copy of the program used to generate graphics.

H. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.10 OBJECT LIBRARIES

A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D. All control objects shall conform to the control objects specified in the BACnet specification.

E. The library shall include applications or objects for the following functions, at a minimum:

1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
2. Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.

1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.
3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an “on” condition. The user must be able to specify either input condition as the “on” condition.
4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
5. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
6. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
7. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple Java-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
8. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
9. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an “On” state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
10. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the “contained” application that are represented on the graphical shell of this container.

G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:

1. For BACnet devices, provide the following objects at a minimum:

a. BACnet AI
b. BACnet AO
c. BACnet BI
d. BACnet BO
e. BACnet Device

2. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

2.11 ALARM MANAGEMENT

A. Alarm management shall be provided to monitor and direct alarm information to operator workstations. The IAS/BMS shall perform distributed, 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 the IAS/BMS ability to report alarms be affected by either the operator or activity at a workstation.

B. A dedicated alarm window shall be provided to view system alarms.

C. On every page, an alarm indication shall flash and an audio alert shall sound when the new alarm occurs. The owner shall be able to click on the alarm indicator and bring up the alarm portal/console for full alarming detail.

D. All alarm or point change reports shall include the point's English language description, prefaced by site location, and the time and date of occurrence. Time shall be posted in hours-minutes-seconds (PST).

E. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories to provide full flexibility in defining the handling of system alarms. The IAS/BMS shall automatically inhibit the reporting of selected alarms during system shutdown and startup. Users shall have the ability to manually inhibit alarm reporting for each point.

F. Alarms reports and messages shall be directed to a user-defined list of operator devices, email addresses or user categories. When an alarm is delivered, it shall provide the location, time stamp of time of occurrence at the delivery station. Delivery of alarm time stamping alone shall not be acceptable.

G. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 1000 character alarm message to more fully describe the alarm condition of direct operator response.

1. Each NAC shall be capable of storing a library of at least 200 alarm messages. Each message may be assignable to any number of points in the controller.

H. The MSI shall provide up to 200 custom alarms. These alarms shall be programmed so that selected users shall be provided with necessary alarms. This shall be in addition to the standard

alarms provided in the point's matrixes. Vendor shall coordinate with owner and engineer to mask low level alarms during an emergency such that only the most critical and immediate alarms shall be annunciated to these selected users.

I. Alarms shall be generated based on their priority. The Owner and Owner's representatives shall direct the contractor to collect, configure, present and trend critical, major and minor alarm points and graphical representations of objects for conditioned monitoring as designated in the attached Point List.

J. If communication with the Operator Workstation is temporarily interrupted, the alarm shall be time-stamped and buffered in the IAS/BMS. When communications return, the alarm shall be transmitted to the Operator Workstation if the point is still in the alarm condition. Loss of controller function and operator work station function communication shall be alarming events which are simultaneously communicated to owner's Local Onsite Management team and Network Operations Center (NOC).

K. The BMS shall be capable of distributing alarm and other custom message through the customer's internal LAN or WAN. This process shall enable users to receive messages via email and any other network connected devices designed for this purpose.

L. The SI shall construct, in coordination with the Owner, an Alarm Escalation process. The alarm escalation process shall identify the alarm categories, recipients based on alarm category and time of day, process for delivering the alarm message and the escalation process if the alarm is not acknowledged in the appropriate/determined time frame.

2.12 DATA HISTORY

A. The IAS/BMS shall automatically accumulate and store runtime hours for all digital input and output points.

1. The totalization routing shall be capable of a sampling resolution of one minute or less.
2. The user shall have the ability to define a warning limit for runtime totalization. Unique user-specified messages shall be generated when the limit is reached

B. The IAS/BMS shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.

1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. kWh, gallons, BTU, tons, etc.).
2. The totalization routine shall have a sampling resolution of one minute or less.
3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

C. The IAS/BMS shall have the ability to count events, such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points.

1. The event totalization feature shall be able to store the records associated with a minimum of 9,999.9 events before reset.
2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached

D. All trend data shall be available for use in 3rd party personal computer applications.

E. All trend data shall be available for a period of two years and operate on a first in – first out basis (FIFO).

2.13 DATABASE BACKUP

A. In the event of the server failure, the operator shall not be required to manually reenter system data.

B. The process of database backup shall be an on-line process. While this process is being executed, any other system operations (such as operator input/output, scanning of field hardware, application software execution, etc.) shall not be interrupted.

2.14 SYSTEM INTEGRATION (OTHER):

A. For sub systems (provided by others) that require integration into the IAS/BMS see the sub-system matrix found in Division 23.

B. Where these systems are provided with a BACnet IP, BACnet MS/TP, Modbus TCP/IP, Modbus RTU, Lon Talk or other communication method the device shall be connected directly to a NAC communication port .The wiring installation and termination for this connection shall be provided by the Division 23 contractor.

C. Where these systems are provided with outputs/inputs the Division 23 contractor shall provide sufficient wiring for those points necessary to accurately monitor and/or control the system(s) as indicated on the plans and/or in the points matrix, through connections to a NAC.

D. The Division 25 contractor shall be responsible providing assistance to the Division 26 Contractor and/or the device/system provider in programming/set up of all sub system devices connected to the BMS through a NAC to assure the information is transmitted properly to the BMS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All work described in this division shall be performed by a system integrator that have a successful history in the design and installation of integrated control systems in multi-site, mission critical Data Centers. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience. Include references and relevant project examples.

B. Install system and materials in accordance with manufacturer’s instructions, and as detailed on the project drawing set. Installation of NAC panels shall be the responsibility of the Division 23, Controls Contractor.

C. Drawings of IAS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Temperature Control sub-contractor in accordance with the specifications in Divisions 23 and 26.

3.2 WIRING

A. All electrical control wiring to the NACs and network components (routers, hubs, switches, etc.) shall be the responsibility of the Division 23, DDCS Contractor.

B. All electrical power wiring to the NACs and network components (routers, hubs, switches, etc.) shall be the responsibility of the Division 26, Electrical Contractor.

C. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All IAS/BMS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where IAS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Acceptance of project by owner will be for entire project, not phased by equipment startup.

C. All work shall have a single warranty date, even when the Owner has received beneficial use due to early system start-up. If the specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

D. Within this period, upon notice by the Owner, any defects in the work provided under this division due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the DDCS Contractor at no expense to the Owner.

3.4 WARRANTY ACCESS

A. The Owner shall grant to the Division 25 System Integrator, reasonable access to the IAS/BMS during the warranty period. The owner shall allow the System Integrator to access the IAS/BMS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 ACCEPTANCE TESTING

A. Upon completion of the installation, the Division 25 System Integrator shall load all system software and start-up the system. The Division 23 contractor shall perform all necessary calibration, testing and debugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications. The Division 23 contractor and the Division 25 System Integrator are to coordinate the checkout of the system such that each Division has a representative present during system checkout.

B. The Division 23 contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation. The Division 25 System Integrator shall have a representative present during system checkout by the Division 23 Contractor.

C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's

Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

D. System Acceptance: Satisfactory completion is when the Division 23, 25 and 26 contractors have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR INSTRUCTION, TRAINING

A. During system commissioning and at such time acceptable performance of the IAS hardware and software has been established the Division 23 contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Division 25 System Integrator shall provide 16 hours of instruction to the owner's designated personnel on the operation of the IAS/BMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the IAS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

1. The training shall be in three sessions as follows:

a. Initial Training: One day session (4 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owner's personnel can start to familiarize themselves with the system before classroom instruction begins.
b. First Follow-Up Training: Two days (2 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
c. Warranty Follow Up: Two days (2 hours total) in no less than 1 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

2. Schedule training for Owner designated personnel with at least 7 days prior notice. Training sessions which are not scheduled or other unauthorized instruction periods are not included in the required minimum 8 hours of dedicated instruction time.

PART 4 - SEQUENCES OF OPERATION

4.1 SUMMARY

A. The Division 25 System Integrator shall refer to this Item under Division 23 to determine the level of control functionality the Network Area Controller must provide, which is the responsibility of this Division. It is the responsibility of the Division 25 System Integrator to coordinate control functions, such as scheduling and supervisory-level global control with the Division 23 contractor.

PART 5 - POINT LISTS

5.1 SUMMARY

A. The Division 25 System Integrator shall refer to this Item developed and provided under Division 23 to determine the data in the local controllers that must be integrated into the Network Area Controller, which is the responsibility of this Division. It is the responsibility of the Division 25 System Integrator to coordinate control functions, such as scheduling and supervisory-level global control with the Division 23 contractor.

END OF SECTION 251300

PART 1 - SECTION 260010 - GENERAL ELECTRICAL REQUIREMENTS

PART 2 - GENERAL

2.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and to all following sections within Division 26.

2.2 SECTION INCLUDES

A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.

B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

2.3 DEFINITIONS

A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:

1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
3. Provide: "To furnish and install complete, and ready for the intended use."
4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental

to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.

5. Engineer: Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division.

    a. A Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.

6. Contract Administrator: Where referenced in this Division, “Contract Administrator” is the primary liaison between the Owner and the Contractor. Specifically, for this project this is “the Architect”.
7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.
9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
    b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

10. Value Engineering: A systematic method to improve the “value” of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
11. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified

B. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

C. The terms "approved equal", “equivalent”, or "equal" are used synonymously and shall mean “accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified”. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

D. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

    1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
3. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference, unless otherwise noted.

E. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
2. Sub-base: as used in this section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.
3. Sub-grade: as used in this section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

2.4 REFERENCE STANDARDS

A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator’s and Engineer’s attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.

B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.

C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

IBC	International Building Code
UBC	Uniform Building Code
ADA	Americans with Disabilities Act
AIA	Guidelines for Design and Construction of Hospital and Healthcare Facilities
AEIC	Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association

ICEA	Insulated Conductors Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code, NFPA 70
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufactures' Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
UL	Underwriter's Laboratories

E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.

G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

2.5 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.

B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.

C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.

D. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.

E. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.

F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

G. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.

H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

2.6 MEASUREMENTS AND LAYOUTS

A. The Drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

2.7 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown 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 trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.

1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
4. Include work provided by others routed through the equipment rooms.

2.8 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements, in addition to requirements specified herein.

B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.

C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time or time specified in the Engineer's Agreement with the Client, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

E. Submittals and shop drawings shall not contain Engineer's firm name or logo, nor shall they contain the Engineer's seal and signature. They shall not be copies of Engineer's work product. If the Contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.

F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division. Provide the number of submittals required by Division 1. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

I. Refer to individual sections for additional submittal requirements.

J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

K. Submittals shall contain the following information:

1. The project name.

2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.

2.9 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
2. The burden of proof of the merit of the proposed substitution is upon the proposer.
3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

    a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
    b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
    c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
    d. Same warranty will be furnished for proposed substitution as for specified Work.
    e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
    f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. Prior to receipt of Bids: No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.

a. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

3. After receipt of Bids: No substitutions will be considered after receipt of Bids and before award of the Contract.
4. After award of Contract: No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

2.10 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet.

B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.

C. Contact the Contract Administrator for written authorization.

D. The following must be received before electronic drawing files will be sent:

1. Contract Administrator’s written authorization
2. Engineer’s release agreement form
3. Payment

2.11 QUALITY ASSURANCE

A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.

B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.

C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

2.12 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish the Operation and Maintenance Manuals to the Contract Administrator, for Engineer’s review, and for the Owner’s use.

1. Refer to Division 01 for acceptance of electronic manuals for this project. If not specified in Division 1, provide manuals in the form of a multiple file composite electronic PDF file for each manual type required. Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size. Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

    a. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator’s and Engineer’s designated representatives.

2. If Division 01 requires paper manuals, provide four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings.

E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

2.13 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections of this Division.

2.14 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

2.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.

D. Be responsible for the safe storage of tools, material and equipment.

2.16 WARRANTIES

A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer’s standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

D. Also warrant the following additional items:

1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
2. All raceway seals are effective.
3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.

E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.

F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.

G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

2.17 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

    a. Vent and exhaust fuel-burning heaters per SMACNA Guidelines for Source Control and equip units with individual-space thermostatic controls.
    b. If permanent HVAC systems are used during construction, provide HVAC Protection and replace all filtration prior to occupancy in accordance with SMACNA Guidelines.

2.18 FIELD CONDITIONS

A. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services that transit the area affected by selective demolition.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.

B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

C. Use of explosives is not permitted.

D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 3 - PRODUCTS AND MATERIALS

3.1 SOIL MATERIALS

A. Sub base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.

B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.

C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than two inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

PART 4 - EXECUTION

4.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

4.2 PERMITS

A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

4.3 TEMPORARY ELECTRICAL SERVICE AND WIRING

A. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.

B. Pay all charges made by the Electric Utility, with respect to installation and energy charges for temporary services.

C. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails, receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.

D. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.

E. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120V, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.

F. Install circuits to points on each level of each building so that service outlets can be reached by a 50-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).

G. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.

H. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.

I. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.

J. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

4.4 SELECTIVE DEMOLITION

A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements in addition to the requirements specified herein.

B. General: Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

C. Materials and Equipment To Be Salvaged: remove, demount, disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

D. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:

a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 26.

4.5 ACCESS TO EQUIPMENT

A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section “Common Work Results for Electrical”.

B. Maintain all code required clearances and clearances required by manufacturers.

4.6 PENETRATIONS

A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 26 Section “Common Work Results for Electrical”.

B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete or block walls.

C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

4.7 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.

C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.

D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.

E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Tanks and Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for electrical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
2. Under building slabs, use drainage fill materials.
3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
5. Other areas use excavated or borrowed materials.

O. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.
2. Removal of concrete formwork.
3. Removal of shoring and bracing, and backfilling of voids.
4. Removal of trash and debris.

P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less that 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.

Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

    a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
    c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

4.8 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

4.9 PAINTING

A. Refer to Division 09 Section “Painting” for painting requirements.

B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.

C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer’s instructions for pre-cleaning surfaces and application.

D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.

E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

4.10 CLEANING

A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from the Work and assist in making the premises broom clean. Clean all material and equipment installed under this Division.

C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.

D. Touch up and restore damaged finishes to their original condition.

4.11 ADJUSTING, ALIGNING AND TESTING

A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.

B. Check motors for alignment with drive and proper rotation, and adjust as required.

C. Check and test protective devices for specified and required application, and adjust as required.

D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.

E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.

F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.

G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.

H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.

I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.

J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.

K. Refer to individual sections for additional and specific requirements.

4.12 START-UP OF SYSTEMS

A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.

B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.

C. Adjust taps on each transformer for rated secondary voltages.

D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.

E. Replace all burned-out lamps. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Owner.

F. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.

G. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.

H. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

4.13 TEST REPORTS

A. Perform tests as required by these Specifications and submit the results in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for

each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.

B. For specific testing requirements of special systems, refer to the Specification section that describes that system.

C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:

1. Building service entrance voltage and amperes at each phase.
2. Electrical service grounding conditions and grounding resistance.
3. Proper phasing throughout the entire system.
4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
5. Phase voltages and amperes at each three-phase motor.
6. Test all wiring devices for electrical continuity and proper polarity of connections.

D. As part of the commissioning process, the General Contractor shall engage a third-party entity to perform a lighting validation survey and provide a report to both the General Contractor and Owner's Construction Manager. This report shall validate lighting levels in all areas inside and outside of the building, this includes but is not limited to: warehouse space, electrical room, fire riser room, loading canopy, site lighting and office areas. Refer to section 265100 "Interior Lighting" and section 265600 "Exterior Lighting" for more information.

E. Promptly correct all failures or deficiencies revealed by these tests as determined by the Engineer.

4.14 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. Submit complete Operation and Maintenance Data.
2. Submit complete Record Drawings.
3. Perform all required training of Owner's personnel.
4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
5. Perform start-up tests of all systems.
6. Remove all temporary facilities from the site.
7. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.

B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days notice prior to the review.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, he shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Contract Administrator will prepare a “final list” of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the “final list” shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 260010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:

1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
2. Sleeves and seals for electrical penetrations.
3. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
4. Sealing penetrations through noise critical spaces.

1.2 DEFINITIONS

A. The following abbreviations apply to this and other Sections of these Specifications:

1. AHJ: Authority(ies) having Jurisdiction
2. ATS: Acceptance Testing Specifications
3. EPDM: Ethylene-propylene-diene monomer rubber
4. MC: Metal Clad
5. N/A: Not Available or Not Applicable
6. NBR: Acrylonitrile-butadiene rubber
7. NRTL: Nationally Recognized Testing Laboratory
8. PCF: Pounds per Cubic Foot

B. The following definitions apply to this and other Sections of these Specifications:

1. Homerun: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.4 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.

1. Offices
2. Conference Rooms

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section “Identification for Electrical Systems” for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Contract Administrator prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

    a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
    b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
    c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

    a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

8. Locking Devices: Flush, screwdriver-operated cam locks.

2.2 SLEEVES

A. Steel sleeves for raceways and cables

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

B. Cast iron wall pipe sleeves for raceways and cables

1. Manufacturers

    a. Josam Mfg. Co.
    b. Smith (Jay R) Mfg. Co.
    c. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
    d. Watts Industries, Inc.
    e. Zurn Industries, Inc.; Hydromechanics Div.

2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with setscrews.

3. Sleeves for rectangular openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
4. Coordinate sleeve selection and application with selection and application of firestopping to be used.

2.3 SEALANTS

A. SLEEVE SEALS

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
2. Manufacturers:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Metraflex Co.
    d. O-Z/Gedney
    e. Pipeline Seal and Insulator, Inc.

3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.

    a. EPDM

b. NBR
c. Neoprene

4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.

   a. Plastic
   b. Carbon steel
   c. Stainless steel
   d. PVC-coated steel

5. Connecting Bolts and Nuts: of length required to secure pressure plates to sealing elements. Include one for each sealing element.

   a. Carbon steel with corrosion-resistant coating
   b. Stainless steel

B. JOINT SEALERS

1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.
3. Elastomeric Joint Sealers: Provide the following types:

   a. Silicone Joint Sealants, One-part nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

      1) Dow Corning, Dowsil 790
      2) Dow Corning, Dowsil 795
      3) GE, Silglaze II SCS 2350
      4) GE, Silpruf SCS 2000
      5) Owens Corning, Energy Complete
      6) Pecora, 864 NST
      7) Tremco, Spectrem 1
      8) Tremco, Spectrem 2

   b. Mildew Resistant Sealants, one-part mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

      1) Dow Corning, Dowsil 786
      2) GE, Momentum SCS 1700
      3) Pecora, 898 Silicone NST

   c. Hybrid Joint Sealants: One-part, nonsag, paintable complying with ASTM C 920, Type S, Grade NS, Class 50 recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent. Subject to compliance with requirements, provide one of the following:

      1) BASF, MasterSeal NP 100

2) Pecora, DyanTrol I-XL
3) Tremco, Dymonic FC

C. FIRESTOPPING

1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ. Subject to compliance with requirements, provide one of the following:

a. Manufacturers:

1) 3M Corp., Fire Barrier Sealant
2) Hilti, Inc.
3) Tremco, Tremstop Fyre-Sil
4) Pecora, AC-20 FTR
5) RectorSeal
6) Specified Technologies Inc. Firestop
7) USG, SHEETROCK Firecode Compound
8) Owens Corning Firestopping Insulation

D. ACOUSTICAL SEALANTS

1. General: Penetrations by conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
2. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.
3. Non-Hardening Penetration Sealant: Non-hardening polysulphide type, Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
4. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m3).
5. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90. Meeting ASTM E 84 for a smoke flame spread index of less than 25 / 50. Subject to compliance with requirements, provide one of the following:

a. Pecora, AC-20 FTR
b. Pecora, AIS-919
c. USG, SHEETROCK Acoustical Sealant.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping”.

C. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

D. Comply with NECA 1.

E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.

F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

H. Right of Way: Yield to raceways and piping systems installed at a required slope.

3.2 ACCESS DOORS

A. Verify the exact location, sizes, and types of all access doors with the Contract Administrator prior to purchase.

B. Provide access doors for all concealed electrical equipment, except where above lay-in ceilings.

C. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

D. Adjust hardware and panels after installation for proper operation.

E. Label all access doors with a nameplate as described in Division 26 Section “Identification for Electrical Systems”.

3.3 SLEEVES AND SLEEVE SEALS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Provide sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical work that passes through such construction. Coordinate with all other trades and divisions to dimension and lay out all such openings.

C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other divisions.

D. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support raceway penetrations.

E. 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. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.

F. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

G. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

H. 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.

I. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.

J. Sleeve Length:

1. Sleeves through walls: Cut sleeves to length for mounting flush with both surfaces of walls.
2. Sleeves through floors: Extend sleeves 2 inches above finished floor level.

K. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed; in which case, size sleeves as recommended by the seal manufacturer.

L. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

M. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint

N. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

O. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

P. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

Q. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.
c. Install galvanized sheet metal for rectangular sleeves
d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

R. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between sleeve and cable or raceway. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
2. Inspect installed sleeve and sleeve-seal installation for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.

S. Concrete Slab on Grade Penetrations:

1. Provide ½" thick cellular foam insulation around perimeter of raceway passing through concrete foundation. Installation shall extend to 2" above and below the concrete slab.

T. Elevated Floor Penetrations of waterproof membrane:

1. Provide cast-iron wall pipes for sleeves. Size wall pipe for minimum ½" annular space between wall pipe and cable or raceway.
2. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.
3. Secure waterproof membrane flashing between clamping flange and clamping ring.
4. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

U. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.

V. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

W. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

X. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

Y. Sleeve-Seal Installation

1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.
2. Use 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.

Z. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.

AA. Sleeves shall be protected throughout the course of construction, and when damaged shall be replace and/or repaired to a satisfactory condition.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.5 JOINT SEALERS

A. Preparation for Joint Sealers

1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.
2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

B. Application of Joint Sealers

1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

2. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.6 ACOUSTICAL PENETRATIONS

A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.

B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it.

After all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

END OF SECTION 260500

SECTION 260502 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope for electrical connections to equipment specified under other sections or divisions, or furnished under separate contracts or by the Owner.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this contract.

B. Coordinate with work described in Division 11 Sections for equipment requiring electrical connection.

C. Coordinate with work described in Division 23 Section “Direct-Digital Control for HVAC”.

D. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

E. Determine connection locations and rough-in requirements based on shop drawings.

F. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

G. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.

2. Marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 CORDS AND CAPS

A. Attachment Plugs: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.

C. Cord: See Paragraph “Flexible Cords” in Division 26 Section “Low-voltage Electrical Power Conductors and Cables”.

D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION, GENERAL

B. Install in accordance with manufacturer's instructions.

3.3 ELECTRICAL DEVICES

A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.4 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturers' instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.5 EQUIPMENT

A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.

B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.

C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.

D. Motorized Damper: Provide lockable toggle, pilot lighted disconnect switch in an accessible location at each motor actuator, or group of motor actuators.

3.6 DOOR OPERATORS AND HARDWARE

A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors, and all other required electrical connections for door systems included in other sections of these specifications.

B. Provide power connection to all equipment as required and as indicated in the equipment supplier’s installation drawings.

C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.

D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with the NFPA codes.

3.7 SIGNAGE AND WAYFINDING

A. Provide junction boxes, disconnect switches and grounding per manufacturer's installation drawings.

B. Coordinate rough-in requirements with signage installation instructions.

C. Coordinate box locations and conduit routing with parapets and roof elevations.

D. Provide labelling on all junction boxes and disconnects in accordance with Division 26 section “Identification for Electrical Systems”

END OF SECTION 260502

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SECTION 260504 - PROVISIONS FOR ELECTRIC UTILITY SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Provisions for Underground Secondary Electrical Service.

B. Utility service voltage:

1. As indicated on the Drawings.

C. Utility service ampacity: As indicated on the Drawings.

D. The extent of Work for the secondary electrical service includes providing the following:

1. Raceways
2. Provisions for Metering
3. Grounding and Bonding
4. Concrete pad for service transformer
5. Service lateral
6. Primary raceways

1.2 QUALITY ASSURANCE

A. Perform all work in accordance with Utility Company installation drawings and service standards.

B. Maintain one copy of Utility Company installation drawings and service standards at the site.

C. Prior to commencing work in this Section, meet with the Utility Company representative to review service entrance requirements and details.

D. Verify that field measurements are as indicated on Utility Company drawings.

E. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
2. Marked for intended use.

F. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS
(Not Used)

PART 3 - EXECUTION

3.1 SECONDARY SERVICE ENTRANCE UNDERGROUND

A. Provide an underground secondary service lateral from the pad mounted transformer in accordance with NFPA 70 Article 230 and the Utility Company standards. Reference the Drawings for service lateral conductor and raceway quantities, sizes, and types.

B. The Utility Company will provide the service transformer.

C. [Provide a concrete pad, complying with the Utility Company standards, for transformer mounting, and set coated GRS conduit elbows and riser(s), with grounding bushing(s), to receive primary and secondary raceways. Where direct burial primary is used, set coated GRS conduit elbow(s) and riser(s), with grounding bushing(s), to receive primary cables.]

D. Make connections to the secondary terminals of the transformer as required and in conformance with Utility Company requirements. Utility Company will provide primary conductors and terminal connections unless otherwise directed by the Utility Company.

3.2 METERING

A. [Provide a 1-1/4-inch empty GRS conduit, with pull cord, from the secondary compartment of the pad-mounted service transformer to the meter location shown on the Drawings, or as directed by Utility Company.]

B. Provide a meter base complying with the Utility Company standards.

C. The Utility Company will provide the meter and meter wiring.

3.3 UTILITY SERVICE CHARGES

A. It shall be the responsibility of the Division 26 contractor to apply for the electrical service, including the preparation and completion of all forms. Submit the completed application along with all other required documentation for the new or modified service.

B. Pay all Utility Company charges for providing electric service, including all charges for bringing primary service conductors to the site.

3.4 FIELD QUALITY CONTROL

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Rebalance loads.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained. Submit results in writing.

END OF SECTION 260504

SECTION 260510 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements as follows:

1. Pathways for Communications Systems

    a. Conduits and Backboxes
    b. Access doors
    c. Fire Stop System Assemblies for Communications Systems
    d. Sleeves entering noise critical spaces

2. Telecommunications Backboards
3. Grounding and Bonding for Communications Systems

1.2 DEFINITIONS

A. Bonding Conductor for Telecommunications (BCT) – the conductor that bonds the TMGB to the service equipment (power) ground.

B. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, and potentially other low-voltage systems such as audio-visual, security and fire alarm (electronic safety and security) equipment. Also known as Telecommunications Room, Telecom Room, IT Room, MDF, or IDF.

C. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

D. IDF – Intermediate Distribution Frame, secondary Communications Room(s) for a building

E. IMC – Intermediate Metal Conduit

F. MDF (Tennisball) – Main Distribution Frame, the Main Communications Room for a building

G. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn’t identified on the drawings, assume the Main Communications Room (MDF) also acts as the Point of Entrance.

H. Primary Bonding Busbar (PBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

I. RCDD – Registered Communications Distribution Designer as certified by BICSI

J. RMC – Rigid Metal Conduit

K. Secondary Bonding Busbar (SBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

L. STC – Sound Transmission Class, a single number decibel rating of the transmission loss properties of an assembly. Measured transmission loss data is plotted versus frequency and compared with standard contours according to rules outlined in ASTM E 90 and ASTM E 413.

M. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar (TGB).

N. Telecommunications Bonding Conductor (TBC) – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

1.3 REFERENCE STANDARDS

A. The references to the following standards and guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON).

1. TIA-569 – "Telecommunications Pathways and Spaces"
2. TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
3. ANSI/NECA/BICSI 607-2011 – Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
4. BICSI Telecommunications Distribution Methods Manual (TDMM)
5. ASTM E 814 and ANSI/UL1479 –"Fire Tests Through Penetration Firestops"
6. ASTM E 84 and ANSI/UL 723 "Surface Burning Characteristics of Building Materials"
7. ASTM E 119 and ANSI/UL 263 "Fire Tests of Building Construction Materials"
8. Telecommunications Service Provider Pathway Requirements

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate arrangement, mounting, and support of communications equipment with Telecommunications equipment furnished by Owner and Telecommunications service providers.

B. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
3. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.

E. Coordinate testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.5 QUALITY ASSURANCE

A. All cable supports shall be manufactured by a company which produces cable supports. No field made apparatus will be accepted without prior written approval.

1.6 NOISE CRITICAL SPACES

A. For Noise-critical spaces, provide Acoustic Pathway Devices as needed and attenuating measures and acoustical sealants as indicated in Division 26, " Common Work Results for Electrical".

PART 2 - PARTS AND MATERIALS

2.1 PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. Raceways and Boxes for Communications Systems

1. General Requirements

a. Refer to Division 26, "Raceways and Boxes for Electrical Systems" for Available Manufacturers and other specific product, material and installation requirements.
b. Outlet boxes located in plenum accessible ceiling space shall be listed for installation in a plenum.
c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the following paragraphs. Manufacturers and model numbers listed are used only to represent the characteristics required and are not intended to restrict the use of other Available Manufacturers models that meet the specified criteria.

2. Back boxes for Telecommunications Systems (Telephone, Data, and Multi-Service Outlets) installed in stud walls:

a. Requirements:

1) Minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth
2) with a single-gang raised cover/extension ring a minimum of 3/8" deep. Depth shall match that of wall gypsum board(s)

b. Manufacturers:

1) Emerson/Appleton
2) Hubbell RACO
3) Randl
4) ABB/Thomas & Betts/Steel City

3. Back boxes for Telecommunications Systems (Telephone, Data, and Multi-Service Outlets) installed in masonry construction:

a. Requirements:

1) Minimum size shall be double gang, a minimum of 3-1/2 inches deep.

b. Manufacturers:

1) Emerson/Appleton
2) Hubbell RACO
3) Randl
4) ABB/Thomas & Betts/Steel City

4. Back boxes for Audio Visual outlets

a. Refer to AV drawings and specifications for exact requirements. When there are no AV drawings/specifications, meet the requirements of this section:
b. Requirements

1) 3-gang
2) Depth shall be 3-1/2 inches.

c. Manufacturers:

1) Hubbell RACO
2) FSR, Inc.
3) Legrand

5. Pull Boxes

a. Refer to Boxes, Enclosures and Cabinets section of Division 26 “Raceways and Boxes for Electrical Systems”.

B. Access Doors for Communications Systems

1. Refer to Execution section for location requirements.
2. Refer to Division 26, “Common Work Results for Electrical” for specific product and material information.

C. Fire stop System Assemblies for Communications Systems

1. General

a. Communications cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple Fire-Rated Pathway Devices for Communications (capacity shall match that of cable tray cross-sectional area), and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.
b. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer’s instructions.
c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.

2. Fire-Rated Pathway Device for Communications - for sleeves through a single penetration (wall or floor)

a. Allows the installation and removal of cables without the need to remove or add any materials.
b. Used to seal penetrations of cables through fire rated partitions.
c. Manufacturer shall be:

1) EZ-Path family of products by Specified Technologies Inc.

2) Or equivalent from Conditionally Approved manufacturer.

3. Firestopping for Communications Backboxes in Fire-Rated Walls

a. Specifications

1) Used to seal communications backboxes in fire rated partitions.
2) Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
3) Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.

b. Manufacturer shall be:

1) Specified Technologies Inc., SpecSeal Power Shield
2) Or equivalent from

a) 3M
b) Hilti

4. Firestopping for Thru-Wall Communications Conduit Penetrations and Other Applications

a. For fire-rated penetrations where the pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications required by Communications Pathways not previously addressed in this specification.
b. Specifications:

1) Shall be UL listed for the specific application;
2) Shall meet or exceed the ratings of the wall or floor that it penetrates.

c. Manufacturer shall be:

1) Specified Technologies Inc., SpecSeal Power Shield
2) Or equivalent from

a) 3M
b) Hilti

D. Sleeves Entering Noise Critical Spaces – Acoustic Pathway Device

1. Where walls or ceiling-mounted Communications Devices are located inside Noise Critical Spaces, and/or for Communications System sleeves through acoustically-rated (non-fire-rated) walls at or above STC-50, provide Acoustic Pathway Device(s) to support low-voltage telecommunications/AV/security cabling.
2. Specifications:

a. Shall maintain STC Rating of the penetrated wall.
b. Shall accommodate cable loads from 0 to 100% visual fill.
c. Shall be zero-maintenance, meaning no action is required by cabling technician to open/close pathway for cable moves, adds, or changes.
d. Shall be engineered such that cables can
e. Where more than one Acoustic Pathway Device is needed, they shall be ganged together with manufacturer supplied grid.

3. Manufacturer shall be:

    a. Specified Technologies EZ-Path Smoke & Acoustical Pathway (NEZ33)

2.2 TELECOMMUNICATIONS BACKBOARD

A. Telecommunications Backboard

1. A minimum of one wall shall be covered with 48 in (1219 mm) wide by 96 in (2438 mm) high 0.75 in (19 mm) plywood, UON on drawings.
2. The backboard shall be sized as indicated on drawings, mounted vertically, with the bottom of the plywood mounted 6 in (150 mm) above the finished floor with the best side toward the room.
3. Plywood shall be A/C grade and finished with two coats of fire-retardant paint.
4. Plywood shall be painted prior to installation of any equipment; mask out one stamp on each sheet of plywood prior to painting.
5. Plywood shall be permanently fastened to the wall by means of wall anchors utilizing galvanized, zinc plated, or stainless steel hardware with a flat head. Finished installation shall have flush appearance with countersunk screw heads to prevent splitting of the plywood. Drywall screws are not acceptable.

2.3 BONDING AND GROUNDING (EARTHING)

A. General

1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the ANSI/TIA-607 Standard “Generic Telecommunications Bonding and Grounding for Customer Premises”. Major components include:

    a. PBB in the Entrance Facility and SBBs in all remaining Telecommunication Rooms and Spaces.
    b. TBC connecting the PBB to the main Electrical Service Ground.
    c. TBB connecting the PBB to all SBBs.
    d. All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the referenced standard.

2. Component Manufacturers:

    a. Chatsworth
    b. Cooper B-Line
    c. Erico
    d. Harger
    e. Hoffman
    f. Panduit

3. Conductor Manufacturers

    a. Shall be from the list of Component Manufacturers; or
    b. Shall be from the list of Manufacturers in Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”.

B. Primary Bonding Busbar (PBB)

1. Specifications

    a. All busbars shall have a clear cover installed to protect connections
    b. Cover shall be:

        1) Plexiglass or plastic
        2) Cover shall be printed with 3/8” lettering “PBB” using appropriate labels.
        3) Of the same manufacturer as the ground bar

    c. A predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs; hole patterns shall be in TIA/BICSI style.
    d. Have minimum dimensions of 1/4 inch thick x 4 inches wide x 20 inches long.
    e. Provide enough length for all connections with 25% growth.
    f. Provided with insulators to electrically isolate busbar from mounting surface.
    g. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.

2. Manufacturer shall be

    a. Harger TGBIP14420TMGB
    b. Chatsworth 40153-020
    c. Or equivalent from Component Manufacturer

C. Secondary Bonding Busbar (SBB)

1. Specifications

    a. Be a predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs
    b. Have minimum dimensions of 1/4 inch thick x 2 inches wide x 12 inches long

        1) Provide enough length for all connection with 25% growth.

    c. Provided with insulators to electrically isolate busbar from mounting surface
    d. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.

2. Manufacturer shall be

    a. Harger TGBI14212TGB
    b. Chatsworth # 13622-012
    c. Or equivalent from Component Manufacturer

D. Bonding Conductor (To main Electrical service ground) for Telecommunications (TBC): Insulated grounding wire with a minimum copper conductor size equal to that of the TBB, with PVC insulation. Shall be UL listed.

1. Specifications

    a. Copper.
    b. Insulated grounding wire with PVC insulation
    c. A minimum copper conductor size equal to that of the largest TBB or other bonding conductor connected to the PBB, UON.
    d. Cable jacket marking: Shall be legible and shall contain the following information:

1) Manufacturer's name
2) Copper Conductor Gauge
3) NRTL listing information

e. Cable jacket shall be green with black lettering
f. A minimum conductor size as indicated on drawings

E. Connectors / Connections

1. Specifications

a. All connectors and connections shall utilize products that are Listed by a NRTL such as UL.
b. All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc.

2. Compression Lugs

a. Specifications

1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.
2) Shall include inspection port.
3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)

b. Manufacturer shall be:

1) Harger GECLB Series
2) Or Approved Equivalent

3. Conductor to conductor connection

a. Specifications

1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.

b. Manufacturer – Exothermic Weld

1) Erico CADWELD
2) Harger Ultraweld
3) Or Approved Equivalent

c. Manufacturer – Irreversible Compression connector

1) Burndy HYGROUND
2) Or Approved Equivalent

4. Connector for conduit to cable

a. Specifications

1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the PBB/SBB.

b. Manufacturer shall be:

1) For 1” diameter and larger conduits – Harger series CPC electro tin-plated pipe lamp
2) For less than 1” diameter conduits – Harger TBGC4SCS elctro tin-plated conduit bonding clamps
3) Or Approved Equivalent

F. Insulated Grounding Bushings

1. Specifications

a. All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
b. Shall be UL Listed for copper conductors.
c. Shall include lug for easy connection of conductor to PBB/SBB.

2. Manufacturer shall be:

a. O-Z/Gedney IBC-L
b. Or Approved Equivalent

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

3.2 PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. General

1. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
2. Permanently mark or tag each raceway at intervals of not more than 75 feet (22.86 m), and each junction box and pull box. Permanently mark or tag each raceway that is stubbed into the ceiling space from an outlet box. Identifying them as “TELECOM” or “AV” as appropriate.
3. Coordinate the following with cable-installing contractor.

a. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
b. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.
c. Provide all communications pathways:

1) So that cables are allowed to be pulled in accordance with referenced standards and guidelines.

2) So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
3) So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines
4) So that the maximum allowable pulling tension is not exceeded
5) To meet the requirements of the structure and the requirements of all other Work on the Project.
6) Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
7) Parallel or perpendicular to building lines or column lines.
8) When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

d. Follow manufacturer's recommendations for allowable fill capacity. Do not exceed load ratings specified by manufacturer.

4. Access to pathways and associated equipment

a. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.
b. Provide an access door where equipment or devices are located above inaccessible ceilings.
c. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
d. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.

B. Conduits and Backboxes for Communications

1. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and owner Standards (if applicable).
2. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
3. Conduits which enter telecommunications rooms shall extend 1 inch (25.4 mm) to 3 inches (76.2 mm) AFF.
4. Flexible conduits may only be used where specifically allowed by these contract documents.

a. Flexible conduit sections shall be less than 20 feet (6.1 m) in length and shall be increased by (1) trade size

5. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.
6. Conduit runs shall not exceed a total of 150-feet (45.7 m).
7. No more than (2) 90° bends, or equivalent will be allowed between pullboxes.

a. Each and any offset shall be considered a 90° bend.
b. A pullbox is required wherever a reverse bend is installed.

8. The minimum bend radius for conduits is

    a. (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.
    b. (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).

9. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
10. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Rated partitions shall be provided with appropriately rated firestop systems. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).
11. PullBoxes

    a. Pullboxes shall be placed in Conveniently Accessible locations.
    b. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
    c. Pullboxes above an accessible ceiling shall:

        1) Be aligned directly over the ceiling grid to allow access
        2) Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles

    d. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
    e. Size pullboxes according to the following chart:

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
¾” or smaller	4”	4”	2-1/8”	Not applicable
1"	4"	16"	3"	2"
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	28"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	6"

12. Provide an empty EMT raceway from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, install raceways to the nearest accessible corridor ceiling or as indicated on the Drawings.
13. No outlet boxes shall be located back-to-back in a wall cavity.

    a. Where possible offset to next stud cavity, but no less than a 6 inches (152.4 mm) separation.

14. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
15. Provide appropriate plaster/mud ring as indicated on the drawings.
16. Provide conduit as indicated on the Drawings or required by this Specification. Minimum communications conduit size shall be 1 inch (25.4 mm). Provide a polypropylene or

monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as Communications, at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged.

C. Fire stop System Assemblies for Communications Systems

1. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.
2. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by approved NRTL by the AHJ and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
3. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes and National Electric Code.
4. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:

    a. Fire stop Manufacturer
    b. Installer and company
    c. Date installed
    d. UL system number with all relevant ratings indicated

3.3 TELECOMMUNICATIONS BACKBOARD

A. Mount Telecommunications Ground Bars (PBB and SSBs) to telecommunications backboard.

3.4 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

A. General:

1. Install telecommunications bonding and grounding conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. “Daisy chaining” of Telecommunications ground bus bars back to the PBB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein
2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications cable management pathways so as to achieve a “coupled bonding conductor” effect.
3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.).
4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.
5. The Telecommunications Bonding Conductor (TBC), each Telecommunications bonding backbone (TBB) conductor, and each Backbone bonding conductor (BBC shall be green or marked with a distinctive green color

a. Marking with a distinctive green color Shall be done at a minimum of every 1 foot (0.3 meter) by appropriate methods
b. Indicate proposed and actual routing of these conductors on overall floor plans in both the pre-construction Shop Drawings and Record Drawings, respectively.

6. Follow additional installation requirements from NECA/BICSI 607-2011 “Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings”.

B. Required Grounding Connections:

1. Provide and install one individual ground wire from each equipment rack/cabinet/frame (installed under this work) to the SBB in the room. Each conductor is to be “home run”; do not “daisy chain” the connections, except as may be indicated on the drawings.
2. Provide and install one individual ground wire from the raised floor system (provided by another specification section) to the PBB. Conductor is to be “home run”; do not “daisy chain” the connections, except as may be indicated on the drawings.
3. Provide and install one individual ground wire from the overhead ladder rack (installed under this work) to the SBB in the room.
4. Where structural steel is available for connection install one individual ground wire to the nearest structural steel for connection.
5. Provide and install all grounding connections as required by Telecommunications set of drawings (if available).

C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
2. Follow the connector manufacturer’s instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.

D. Cable Identification:

1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following in addition to specific labeling requirements for each conductor.

IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER

E. Quantities of Ground Wire

1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.
2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct

quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)

1. Subject to the applicable electrical code and the reference standards and guidelines, the TBC, TBB, BBC conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from ANSI/TIA-607):

Linear Length (ft)	AWG Size
less than 13	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 kcmil
126-150	300 kcmil
151-175	350 kcmil
176-250	500 kcmil
251-300	600 kcmil
Greater than 301	750 kcmil

G. Testing

1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.
2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.
3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):

    a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance

1. Upon receipt of the Contractor’s documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

END OF SECTION 260510

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Conductors, cables, and cords rated 600V and less.
2. Connectors and terminations rated 600V and less.

1.2 DEFINITIONS

A. The following abbreviations apply to this and other Sections of these specifications:

1. MC: Metal Clad
2. NBR: Acrylonitrile-butadiene rubber
3. NETA ATS: Acceptance Testing Specification.

B. The following definitions apply to this and other Sections of these Specifications:

1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard.

a. Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and temperature deration.
2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
3. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

B. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.4 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.

C. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

D. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.

E. 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.

F. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Contract Administrator and obtain direction before proceeding with work.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner, or others, unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner’s written permission.
3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.

C. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.7 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section “Seismic Controls for Electrical Systems” and Division 20 Section “Seismic Controls for MEP/F/T Systems”.

PART 2 - PRODUCTS AND MATERIALS

2.1 CONDUCTORS AND CABLES - GENERAL

A. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable.

1. Solid conductors for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger
2. Stranded for all flexible cords, cables, and control wiring.

3. As noted otherwise below.

B. Conductor Material: Compact stranded, aluminum alloy (AA-8000 Series), complying with ICEA S-95-658/NEMA WC70; No. 2/0 AWG or larger only

C. Conductor Insulation: Type THHN/THWN-2 complying with ICEA S-95-658/NEMA WC70.

D. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).

E. Conductors shall not be smaller than No. 12 AWG, with the exception of wiring for signal and pilot control circuits; and pre-manufactured whips for light fixtures which may be No. 14 AWG.

F. Conductors installed for site electrical work shall be no smaller than No. 10 AWG CU. All site electrical branch circuit wiring shall be sized such that the maximum branch circuit voltage drop is less than 3 percent.

G. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.

H. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

2.2 SINGLE CONDUCTORS

A. Available Manufacturers:

1. Alan Wire
2. Cerrowire
3. Colonial Wire & Cable Co., Inc.
4. Encore Wire Corporation
5. General Cable (Prysmian Group)
6. Northern Cables Inc.
7. Okonite Company
8. Southwire Company

B. 600V, insulated conductors as noted above shall be color-coded as follows, unless noted otherwise:

PHASE	120/240V	240Δ/120V	208Y/120V	480Y/277V
A	Black	Black	Black	Brown
B	Red	Orange	Red	Orange
C	N/A	Red	Blue	Yellow
Neutral	White	White	White	Gray**
Equipment Ground	Green	Green	Green	Green
Isolated Ground	N/A	N/A	Green/Yellow Stripe	Green/Yellow Stripe

**Except as provided in NFPA 70.

2.3 METAL CLAD CABLE; TYPE MC

A. General:

1. Shall not be used for life safety or critical systems.

B. MC Cable (with insulated green grounding conductor, no bonding conductor):

1. Manufacturers:

   a. Atkore/AFC Cable Systems
   b. Cerrowire
   c. Encore Wire Corporation (MC)
   d. Kaf-Tech
   e. Northern Cables, Inc.
   f. Southwire Company (Amorlite)

2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
3. Armor Assembly: Aluminum interlocked armor (aluminum color).
4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NFPA 70.
6. Marking: Cable markings shall comply with the requirements of NFPA 70.

C. MC Cable (with 0-10V dimming control wiring):

1. Manufacturers:

   a. Atkore/AFC Cable Systems
   b. Cerrowire
   c. Encore Wire Corporation (MC- LED)
   d. Southwire Company (MC – PCS Duo)

2. 600V, Unjacketed and/or PVC-jacketed UL Standard 83, UL Standard 1569 for Type MC, UL Standard 1685, Federal Specification A-A59544, IEEE 1202 Vertical Cable Tray Flame Test and NFPA 70. Type MC Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.
3. Armor Assembly: Aluminum interlocked armor (aluminum color).
4. Phase Conductors: Solid soft-drawn copper, THHN-insulated single conductors, color code: ICEA Method 1.
5. Grounding Conductor: Solid soft-drawn copper, THHN/THWN-2 green insulated grounding conductor sized per NFPA 70.
6. Control Conductors: Color-coded Class 2/Class 3 twisted jacketed pairs
7. Marking: Cable markings shall comply with the requirements of NFPA 70.

D. MC Cable Fittings:

1. Manufacturer & Model:

   a. ABB/T&B
   b. Arlington
   c. Eaton/Crouse-Hinds
   d. Emerson/O-Z Gedney

2. Fittings used for connecting Type MC cable to boxes, cabinets, or other equipment shall be UL listed and identified for such use with an MCI-A marking on the fitting carton or package.
3. Fittings shall be insulated type not requiring the use of anti-short bushings.
4. Romex style, clamp type fittings are not acceptable.

2.4 MANUFACTURED WIRING SYSTEMS

A. Manufacturers:

1. Acuity – ReLoc
2. Cooper Industries

B. Description: Manufactured wiring assemblies complying with NFPA 70, and listed and labeled as complying with UL 183.

C. Provide components necessary to transition between manufactured wiring system and other wiring methods.

D. Branch Circuit Cables:

1. Conductor Stranding (Size 10 AWG and Smaller): Solid.
2. Insulation Voltage Rating: 600 V.
3. Insulation: Type THHN.
4. Provide dedicated neutral conductor for each phase conductor.
5. Grounding: Full-size integral equipment grounding conductor.

a. Provide additional isolated/insulated grounding conductor where indicated or required.
b. Provide redundant grounding, suitable for general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities where indicated or required.

6. Armor: Steel, interlocked tape.

E. Connectors: Keyed and color-coded to prevent interconnection of different voltages.

F. Fixture Leads: Type TFN insulation.

2.5 FLEXIBLE CORDS

A. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, extra-hard-usage; Type SEO, SO, or STO for indoor dry and damp locations; SEOW, SOW, or STOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

1. Manufacturers:

a. Cerrowire
b. Southwire

B. 300V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant black jacket, hard-usage; Type SJEO, SJO, or SJTO for indoor dry locations; SJEOW, SJOW, or SJTOW for damp,

wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.

1. Manufacturers:

    a. Cerrowire
    b. Southwire

2.6 CONTROL WIRING

A. Refer to Division 23 Section “Direct-Digital Control for HVAC”

B. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.

2.7 CONNECTORS

A. Manufacturers:

1. AMP; Tyco
2. FCI-Burndy
3. Gould
4. Ideal Industries, Inc.
5. Ilsco
6. NSi Industries, Inc.
7. O-Z/Gedney
8. Panduit
9. Thomas and Betts
10. 3-M Electrical Products Division

B. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, circumferential compression type (Burndy "Hylug”, or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.

1. Termination fittings: 1- or 2-hole pad and inspection port.

C. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.

1. Termination fittings: 1- or 2-hole pad and inspection port.

D. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts. Color-coded for size, except use green only for grounding connections.

E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: flanged fork-tongue type.

F. Connectors and terminations for aluminum conductors and cables No. 1 and larger: UL 486B listed and marked AL7CU for 75 deg C rated conductors and AL9CU for 90 deg C rated conductors.

G. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

H. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

PART 3 - EXECUTION

3.1 PREPERATION

A. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

B. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.

C. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).

D. Where anticipated conductor installed lengths exceed the lengths indicated on the Drawings, notify Contract Administrator. Provide tabulated list of exceeded lengths for review. Increase conductor size, circuit ground size, and conduit size accordingly to meet maximum voltage drop indicated within the calculations.

3.2 INSTALLATION

A. General

1. Unless otherwise indicated on the Drawings on in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 6 inches of conductor at outlets for fixture or device connections.
2. Install in accordance with manufacturer’s instructions.
3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
4. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
5. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.
6. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.
7. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
8. Multi-wire branch circuits are not allowed unless noted otherwise on the drawings.
9. Where multi-wire branch circuits are utilized (i.e., shared neutral), shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch

circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two examples.

10. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
11. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
12. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply, which are in addition to those in NFPA 70:

    a. Emergency Power Circuits – includes all circuits covered under Articles 700, 701 and 702.

        1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.
        2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.

    b. Normal or Non-Essential circuits.

        1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: 3/4 inch. For greater than eight conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.
        2) The minimum wire size for all conductors in this raceway: No. 10 AWG.
        3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.

    c. GFCI-protected circuits.

        1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.

13. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.
14. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.
15. Branch circuit conductors shall be copper.
16. All essential power systems circuits shall be copper.
17. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:

    a. Wet or dry locations, in raceways:

        1) Service entrance: Type THWN, THHN/THWN-2, or XHHW.
        2) Feeders and branch circuits: Type THWN, THHN/THWN-2, or XHHW.
        3) Conductors No. 6 AWG and smaller: Types THWN or THHN/THWN-2.

    b. Direct buried:

        1) Service entrance: USE.
        2) Feeders and branch circuits: UF or USE.

B. Aluminum Conductor Option:

1. Terminations: Tinned, compression type only; UL-listed for copper and aluminum conductors at 75 degrees C minimum.
2. Increase the raceway size as required, at no additional cost to the Owner, to accommodate the increased size of the aluminum conductors.
3. Aluminum conductor size shall meet or exceed the ampere rating of the scheduled copper conductors at 75 degrees C.
4. Aluminum option applies only for the following feeders or services with minimum size as indicated in “Conductors and Cables” materials section above. All feeders and services smaller than the minimum size or those not listed below shall be copper:

    a. Service entrance conductors
    b. Feeders to switchboards
    c. Feeders to panelboards

        1) Exception: Apartment unit load center feeder conductors shall be copper; aluminum is not acceptable.

    d. Feeders to transformers

5. Where aluminum conductors terminate existing panelboards, switchboards or switchgear that utilize compression connections use hydraulic-compression type connectors with a zinc base, anti-oxidizing compound. Use compression tools of the type that will not release unless the correct pressure has been applied.
6. Measure the temperature of all aluminum conductors at all splices and terminations. Make each test under typical building load conditions after the building is occupied and in operation for a minimum of two weeks. Replace all joints or splices indicating excessive heating.
7. Take measurements with a non-contact type infrared thermometer, with target size not exceeding one inch at five feet and an accuracy of two percent or better. Submit the meter specifications and calibration date with the test results.

C. Metal Clad Type MC Cable:

1. Securing and Supporting:

    a. Support per NFPA 70 for MC cable
    b. Secure cable within 12 inches of every box or fitting.
    c. Secure/supporting intervals shall not exceed six (6) feet for MC cable.
    d. Utilize steel cable hangers, Arlington SMC series or equivalent, for MC cable support wherever possible so as to provide for cable routing in a neat and workmanship like manner.

2. Type MC cable may only be used:

    a. In lieu of flexible conduit and wiring from light fixtures in accessible ceilings to junction boxes (attached to building structure) above the ceiling. Provide cable whips of sufficient lengths to allow for relocating each light fixture within a 5-foot radius of its installed location, but not exceeding 6 feet in unsupported lengths.
    b. For vertical drops in stud walls.
    c. In lieu of metal raceway, only for 15A and 20A branch circuits with up to four (4) conductors, not including grounding and/or bonding conductor(s), and only in dry concealed locations above grade, except where specifically not permitted by NFPA 70.

3. MC cable shall not be used for any use not listed in the paragraph above. Examples of those uses include, but are not limited to:

a. Unjacketed MC:

1) In locations not permitted by NFPA 70.
2) When specifically not allowed by the local AHJ and/or Owner/Landlord.
3) Homeruns to panelboards.
4) Where exposed to view.
5) Where subject to physical damage.
6) Corrosive or Hazardous locations.
7) Wet locations.
8) Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
9) Within mechanical, electrical or telecommunication equipment rooms.
10) Emergency circuits covered by NFPA 70

b. PVC Jacketed MC:

1) In locations not permitted by NFPA 70.
2) When specifically not allowed by the local AHJ[and/or Owner/Landlord].
3) Homeruns to panelboards.
4) Where exposed to view.
5) Where subject to physical damage.
6) Branch circuits serving HVAC, elevator/escalator, medical and kitchen equipment loads.
7) Within mechanical, electrical or telecommunication equipment rooms.
8) Emergency circuits covered by NFPA 70.

D. Flexible Cords

1. Refer to Division 26 Section, “Equipment Wiring Systems”, for electrical connections to equipment.

E. Control Wiring

1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or otherwise specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.

a. Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.

F. Connections:

1. Apply a zinc based, anti-oxidizing compound to connections.
2. 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. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
4. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

5. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.
6. Use connectors as indicated in equipment schedules. Where not indicated use connections as noted below.

    a. Compression – Conductors No. 8 AWG and larger to panelboards, switchboards and apparatus
    b. Compression – splices, terminals
    c. Mechanical – where temporary removal is required

7. Do not use terminals on wiring devices to feed through to the next device.

3.3 IDENTIFICATION

A. General: Provide all identification per Division 26 “Identification for Electrical Systems”.

B. Single Conductors: Identify and color-code conductors to indicate voltage and phase according to Part 2 of this Section. Identification method shall be either:

1. Factory provided colored insulation
2. Color-Coding Conductor Tape.
3. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

C. Power-Circuit Conductor Identification: For primary and secondary conductors 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes identify voltage, source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box identify each ungrounded conductor according to voltage, source and circuit number.

E. Conductors to Be Extended in the Future: Attach identification device to conductors and list source and circuit number.

F. 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.

G. Conductors for controls (lighting, controls): Label each conductor with Markers for Conductor and Control Cables. – identify conductors using method as noted in Division 26 Section “Identification for Electrical Systems”. Note conductor identification on record Drawings.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

I. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

J. Low voltage cable sheath labels and related manufacturer information shall remain apparent in all exposed applications.

1. Protect exposed cabling labels from painting and overspray (this includes protection of cables in cable tray)

3.4 FIELD QUALITY CONTROL

A. Do not perform insulation resistance tests of the distribution wiring to equipment with the surge protective devices installed. Disconnect surge protective device before conducting insulation resistance tests and reconnect immediately after the testing is over.

B. Testing: Perform the following field quality-control testing:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. 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.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. This Section includes:

1. Grounding Conductors
2. Connector Products
3. Grounding Electrodes
4. Ground Bars
5. Miscellaneous Grounding Materials and Products

1.2 DEFINITIONS

A. The following apply to this and other Sections of these Specifications:

1. Ground ring: Bare underground grounding conductor encircling the building or structure.
2. NETA ATS: Acceptance Testing Specification.
3. EMT: Electrical metallic tubing.
4. ENT: Electrical nonmetallic tubing.
5. FMC: Flexible metal conduit.
6. IMC: Intermediate metal conduit.
7. LFMC: Liquidtight flexible metal conduit.
8. LFNC: Liquidtight flexible nonmetallic conduit.
9. RMC: Rigid Metal Conduit
10. GRS: Galvanized Rigid Steel Conduit
11. RAC: Rigid Aluminum Conduit
12. RNC: Rigid nonmetallic conduit.
13. PSF: Pounds per Square Foot

1.3 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS (current version), "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Testing Agency Qualifications: An independent testing 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.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
2. Marked for intended use.

3. Comply with UL 467.

E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

F. Comply with NFPA 70.

PART 2 - PRODUCTS AND MATERIALS

2.1 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

A. Manufacturers:

1. ABB, Inc.
2. Advanced Lightning Technology (ALT)
3. AFL Global
4. Boggs, Inc.
5. Burndy; Hubbell.
6. Cooper Power; Eaton.
7. Copperweld Corp.
8. ECN/Korns; Division of Robroy Industries.
9. Erico; nVent.
10. Galvan Industries, Inc.
11. Greaves Corp.
12. Harger.
13. Hastings Fiber Glass Products, Inc.
14. Heary Brothers Lightning Protection Co.
15. Ideal Industries, Inc.
16. ILSCO.
17. Lightning Master Corp.
18. Lyncole XIT Grounding; Division of VFC.
19. O-Z/Gedney Co.; Emerson.
20. Panduit, Inc
21. RACO; Hubbell, Inc.
22. Robbins Lightning, Inc.
23. Superior Grounding Systems, Inc.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Common Work Results for Electrical."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.

E. Underground Conductors: Bare-copper conductor, No. 2/0 AWG minimum stranded, unless otherwise indicated.

F. Bare Copper Conductors:

1. Solid Conductors: Comply with Conductors: ASTM B 8.
2. Tinned Conductors: Comply with ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.

H. Ground Ring:

1. Bare copper grounding conductor, size as noted on Drawings but not less than #2/0 AWG.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors

C. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:

1. Company symbol and/or logo.
2. Catalog number.
3. Conductors accommodated.
4. Installation die index number or die catalog number is required.
5. Underwriters Laboratories “Listing Mark:”.
6. The words “Suitable for Direct Burial” or, where space is limited, “Direct Burial” or “Burial” per UL Standard ANSI/UL467 (latest revision).

D. Cast connectors: copper base alloy according to ASTM B 30 (latest revision).

E. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: UL-listed:

1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
2. Size: 5/8 inch by 8 feet. Provide sectional types when longer rods are indicated.

B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a bare conductor sized, at a minimum, for the size of the connecting grounding electrode conductor.

C. Ground Plates: UL-listed, rectangular, bare solid copper plate; minimum 0.032-inch thick.

D. Ground Ring:

1. Bare copper grounding conductor, size as noted on Drawings but not less than #2/0 AWG.

2.5 GROUND BARS

A. General

1. Ground bars described in this section are intended to be wall mounted bars used for grounding and bonding. Equipment ground buses for switchboards, panelboards and miscellaneous equipment are described in the individual equipment sections.
2. Supports: Minimum of two each 1-1/2-inch insulators and 1-inch stainless steel offset mounting brackets.

B. Electrical Room Ground Bars

1. Rectangluar Ground Bars: bare, ¼ inch thick, electrolytic, tough pitch copper bar, 4 inches wide. Length as indicated on the Drawings but not less 24 inches long. Hole spacing as required for conductor lugs.

C. Telecommunications Main Grounding Busbar (TMGB)

1. Rectangular Ground Bars: UL & cUL Listed to UL467 & C22.2 respectively, pre-drilled per TIA/EIA Standard 607A, bare, 1/4 inch thick, electrolytic, tough pitch copper bar, 4 inches wide. Length as indicated on the Drawings but not less than 24 inches long.

2.6 MISCELLANEOUS

A. Test Wells:

1. Traffic Areas: Polymer concrete reinforced with heavy weave fiberglass; H-20 load rating; minimum 24 inches deep.
2. Non-traffic Areas: High density polyethylene; 350 PSF minimum load rating; minimum 10.25 inches deep.
3. Cover: Factory-identified by permanent means with word "GROUND".

B. Ground Enhancing Backfill: Provide low-resistivity, ground-enhancing backfill material recommended by the electrode manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Contract Administrator and the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of NFPA 70 and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.
2. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.

3. Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Application:

1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
2. Underground Grounding Conductors: Unless noted otherwise, bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

C. Grounding Electrode System: Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.

1. Provide continuous grounding electrode conductors without splice or joint.
2. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
3. Ground Rod Electrodes:

    a. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
    b. Unless otherwise indicated, install ground rod electrodes vertically.

        1) Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
        2) Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.

    c. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70. If depth is unachievable, notify Contract Administrator and Engineer.
    d. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
    e. Verify that final backfill and compaction has been completed before driving rod electrodes.
    f. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade, pavement, or floor.

4. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches. Use exothermic weld to secure grounding electrode conductor.
5. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare, tinned copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor above footer and foundation and connect to building structural steel or other grounding electrode external to concrete.
6. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

7. Ground Ring Electrode (Counterpoise):

    a. Provide a ground ring encircling the building or structure, in direct contact with earth., installed at a depth of not less than 18 inches or 6 inches below the official frost line, whichever is greater.
    b. Locate ground ring conductor at least 24 inches outside building perimeter foundation, unless noted otherwise on the Drawings.
    c. Provide ground enhancement material around conductor where indicated.

8. Metal In-Ground Support Structures: Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
9. Metal Poles Supporting Outdoor Luminaires: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

D. Equipment Grounding Conductors:

1. Comply with NFPA 70, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
2. Install equipment grounding conductors in all feeders and branch circuits.
3. In branch circuit and feeder raceways, use insulated equipment grounding conductors.
4. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
5. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components. On water heaters, bond metal hot and cold water pipes together, across the heater tank.
6. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

E. Ground Bars:

1. Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.

    a. Use insulated spacers and mounting brackets, and support from wall 2 feet above finished floor, unless otherwise indicated.

F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ground bar.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Separately Derived Systems: Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the Drawings or as required by NFPA 70, whichever is larger.

H. Bonding: Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70:

1. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
2. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
3. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
4. Bond metallic elements likely to become energized or where indicated on the Drawings, including but not limited to fences around electrical equipment and metal drain bodies near pools or electrical equipment.
5. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
6. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in PVC conduit.
7. Pole Mounted Luminaires: Bond metal enclosures and components of pole mounted luminaires to the grounding system per the Manufacturer’s requirements.

3.3 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:

1. Connecting conductors together.
2. Connecting conductors to ground rods, except at test wells.
3. Connecting conductors to building steel.
4. Connecting conductors to plates.

C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

1. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:

a. Connecting conductors together.
b. Connecting conductors to building steel.
c. Connecting conductors to ground rods, except at test wells.

D. Mechanical Pressure-Type Connections: Tighten screws and bolts for grounding and bonding 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.

1. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:

a. Connecting conductors to ground rods at test wells.
b. Connecting conductors to pipes.

E. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise encircling the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade, or 6 inches below the official frost line, whichever is greater, and 6 inches from the foundation.

3.5 IDENTIFICATION

A. Provide identification as specified in Division 26 “Low-Voltage Electrical Power Conductors and Cables” and “Identification for Electrical Systems”.

3.6 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
4. Inspect and test in accordance with NETA ATS, except Section 4.
5. Perform inspections and tests listed in NETA ATS, Section 7.13.
6. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
7. Perform point–to–point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
8. Test Values:

    a. The resistance between the main grounding electrode and earth ground shall be no greater than 5 ohms.
    b. Equipment Rated 500 kVA and Less: 10 ohms.
    c. Equipment Rated 500 to 1000 kVA: 5 ohms.
    d. Equipment Rated More Than 1000 kVA: 3 ohms.
    e. Substations and Pad-Mounted Switching Equipment: 5 ohms.
    f. Manhole Grounds: 10 ohms.

9. Minimum system neutral–to-ground insulation resistance: one megohm.
10. Investigate point-to-point resistance values that exceed 0.5 ohms.

    a. Check for loose connections.
    b. Check for absent or broken connections.
    c. Check for poor quality welds.
    d. Consider other reasons.

11. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements
12. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.

3.7 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 260526

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SECTION 260529 - 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 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
6. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
7. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

B. Coordination Drawings: Conduit routing 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. Structural members in path of conduit groups with supports.
2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

C. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Seismic Requirements: Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 20 Section “Seismic Controls for MEP/F/T Systems”.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. General:

1. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. Manufacturers:

a. Allied Tube & Conduit.
b. Eaton.
c. Enduro Composites.
d. Fabco Plastics Wholesale Limited.
e. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles.
4. Rated Strength: Selected to suit applicable load criteria.
5. Flammability: Fire retardant with NFPA 101, Class A flame spread index (maximum of 25) when tested in accordance with ASTM E84; self-extinguishing in accordance with ASTM D635.

D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

E. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

1. Conduit Straps: One-hole or two-hole type.
2. Conduit Clamps: Bolted type unless otherwise indicated.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-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.

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

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Powers Fasteners, Inc;
5) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

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.

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

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

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.

I. Wire Rope Hanging Systems:

1. Manufacturers:

a. Gripple.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
4. Wire Rope: Zinc coated, stainless steel or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.
5. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

2.2 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 05 Section "Metal Fabrications" for steel shapes and plates.

C. Rooftop support assemblies: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane.

1. Conduit supports: Unless noted otherwise, surface mounted fittings not requiring any attachment to the roof structure and not penetrating the roofing assembly with support fixtures.
2. Equipment supports: Attachment fittings for connection to roof structure.

D. Base Sizes: As required to prevent overturning and to distribute load sufficiently to prevent indentation of roofing assembly.

E. Mounting Height: Provide minimum clearance of 6 inches under supported components to top of roofing.

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. Unless specifically indicated or approved by the Contract Administrator and Structural Engineer, do not support from roof deck.

C. Where support wires are permitted, identify independent electrical component support wires above accessible ceilings with color distinguishable from ceiling support wires in accordance with NFPA 70.

D. Steel Components: Use corrosion resistant materials suitable for the environment where installed.

1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
2. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.

E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:

1. Minimum rod size shall be 1/4 inch (6 mm) in diameter, unless otherwise indicated.

a. Equipment Supports: 1/2 inch diameter minimum.
b. Busway Supports: 1/2 inch diameter minimum.
c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter minimum.
d. Trapeze Support for Multiple Conduits: 3/8 inch diameter minimum.

2. Space supports for EMT, IMC, and RMC as required by NFPA 70.

F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

H. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer’s instructions. Supported load shall not exceed manufacturer’s recommended load rating.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Install in accordance with manufacturer's instructions.

E. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.

F. 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 (90 kg).

1. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.

G. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

H. Do not use products for applications other than as permitted by NFPA 70 and product listing.

I. Remove temporary supports when no longer required.

J. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

K. 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.

    a. 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 (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.

5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

L. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

D. Minimize overhanging materials and protrusions, and provide protective caps and fittings on exposed material ends where:

1. Accessible to untrained personnel.
2. Located within confined spaces.

E. Rooftop support assemblies:

1. Conduit supports: Unless noted otherwise, coordinate installation of support system after roofing materials are complete. Provide adhesive materials to secure conduit supports where required. Where attachment to roof structure is required or otherwise specified, coordinate installation of supports with roofing material installation.
2. Equipment supports: Coordinate installation of supports with roofing material installation.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) 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 (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 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.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 painting Sections 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.

D. Inspect support and attachment components for damage and defects. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUREMENTS

1.1 SUMMARY

A. This Section includes:

1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. EMT: Electrical Metallic Tubing
2. FMC: Flexible Metal Conduit
3. GRS: Galvanized Rigid Steel Conduit
4. IMC: Intermediate Metal Conduit
5. LFMC: Liquidtight Flexible Metal Conduit
6. LFNC: Liquidtight Flexible Nonmetallic Conduit
7. RAC: Rigid Aluminum Conduit
8. RMC: Rigid Metal Conduit
9. RNC: Rigid Nonmetallic Conduit
10. RTRC: Reinforced Thermosetting Resin Conduit

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of raceway, boxes, or other potential obstructions within the dedicated equipment spaces and working clearances for equipment installed by other trades in accordance with the codes and manufacturer requirements.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated. Coordinate the work with other trades to preserve insulation integrity.

1.4 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.

2. Marked for intended use.

C. Comply with NFPA 70.

1.5 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 “Seismic Controls for Electrical” and Division 20 Section “Seismic Controls for MEP/F/T Systems”.

PART 2 - PRODUCTS AND MATERIALS

2.1 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

A. Metal Conduit And Tubing

1. Manufacturers:

a. ABB, Inc.
b. Atkore
c. American Conduit
d. Anamet Electrical, Inc.
e. Electri-Flex Co.
f. Hubbell (Fittings).
g. Nucor Tubular Products.
h. O-Z/Gedney Co.; Emerson.
i. Southwire Company, LLC
j. Western Tube and Conduit Corporation.
k. Wheatland Tube Co.

2. RMC:

a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.

1) Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.04 inches (1mm), minimum.

b. RAC: ANSI C80.5, UL6A.

3. IMC: ANSI C80.6, UL 1242.

a. Plastic-Coated IMC and Fittings: NEMA RN 1, UL-listed.

4. EMT and Fittings: ANSI C80.3, UL 797.

a. Fittings: Set-Screw or Compression type.

5. FMC: Aluminum or Zinc-coated steel: UL 1.
6. LFMC: Flexible steel raceway with PVC jacket: UL 360.

a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Manufacturers:

    a. ABB, Inc.
    b. American Pipe and Plastics, Inc.
    c. Anamet Electrical, Inc.
    d. Atkore
    e. Cantex Inc.
    f. Carlon
    g. Champion Fiberglass, Inc.
    h. Electri-Flex Co.
    i. Hubbell Inc. (Fittings)
    j. IPEX USA, LLC.
    k. Prime Conduit.
    l. Southwire Corporation.
    m. Superflex Ltd.
    n. United Fiberglass of America, Inc.

2. RNC: Schedule 40 PVC: NEMA TC 2, UL 651.

    a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.

3. RTRC (Fiberglass): UL 2420 UG, NEMA TC 14; SW (Standard Wall), HW (Heavy Wall) or XW (Extra Heavy Hall)

C. Metal Wireways

1. Manufacturers:

    a. BEL Products, Inc.
    b. Cooper B-Line
    c. EPI-Electrical Enclosures
    d. Hoffman.
    e. Square D.

2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA 3R.
3. 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. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.
4. Wireway Covers:

    a. Hinged type

5. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.

D. Nonmetallic Wireways

1. Manufacturers:

    a. ABB, Inc.
    b. Enduro Composite Systems

c. Hoffman.

2. Description: Fiberglass reinforced polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Gasketed cover with oil-resistant gasket material.

a. Corrosion resistant captive screws

3. Description: PVC, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
4. 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.
5. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Surface Metal Raceways

1. Manufacturers:

a. ABB, Inc.
b. Hubbell, Inc.
c. Legrand.
d. Mono-Systems, Inc.
e. Panduit Corp

2. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

F. Surface Nonmetallic Raceways

1. Manufacturers:

a. ABB, Inc.
b. Enduro Composite Systems.
c. Hubbell, Inc.
d. Legrand.
e. Mono-Systems, Inc.
f. Panduit Inc.

2. Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.2 BOXES, ENCLOSURES AND CABINETS

A. General

1. Manufacturers:

a. ABB, Inc.
b. American Midwest Power
c. Appleton/O-Z Gedney Co.; Emerson.

d. BEL Products, Inc.
e. Cooper Crouse-Hinds; Eaton.
f. Erickson Electrical Equipment Co.
g. FSR, Inc.
h. Hoffman.
i. Hubbell, Inc.
j. Legrand.
k. Molex; Koch Industries.
l. Robroy Industries, Inc.; Enclosure Division.
m. Spring City Electrical Manufacturing Co.

2. Provide products listed, classified, and labeled as suitable for the purpose intended. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
2. Cast Metal Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover. Furnish with threaded hubs.

a. List and label as complying with UL 514A for non-hazardous locations;
b. List and label as complying with UL 886 for hazardous locations, where required.

3. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
4. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
5. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
6. Minimum Box Size, Unless Otherwise Indicated:

a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
b. Communications Systems Outlets: Comply with Section 27 10 05.
c. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
d. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.

7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Wall Plates: Comply with Division 26 Section “Wiring Devices”.

C. Boxes for telephone, data, telecommunications and audio-video outlets, refer to:

1. Division 26 Section “Common Work Results for Communications”

D. Junction and Pull Boxes Larger Than 100 cubic inches:

1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, and list and label as complying with UL 514A.
2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron or aluminum with gasketed cover.
3. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
4. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

E. Cabinets and Enclosures

1. General:

a. Compliance: NEMA 250, and list and label as complying with UL 50 and UL50E or 508A, as applicable.
b. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes: Shall be keyed. Provide 2 keys for each enclosure.

1) All locks shall be keyed alike.

c. NEMA 250 Environment ratings:

1) NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.
2) NEMA Type 3R: Code-gauge galvanized steel with drip shield top, seam-free front, side, and back; non-gasketed continuous-hinged door, with stainless steel pin; captive, plated steel cover screws; hasp and staple for padlocking; collar studs.

d. Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.
e. Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring. Provide wire management troughs where practicable.
f. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

2.3 FACTORY FINISHES

A. Interior Finish: All interior components shall be factory finished; manufacturer’s standard grey unless otherwise noted.

B. Exterior Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Install in accordance with manufacturer’s instructions.

3.2 RACEWAYS

A. General

1. 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.
2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 1/2 inch (concealed and exposed); 1 inch (underground and under slab).

    a. 1/2 inch conduit shall contain maximum (5) #12AWG conductors or (3) #10AWG conductors.
    b. 3/8 inch flexible conduit may be used for light fixture whips.

3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.
4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.
5. Install grounding bushings on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.
6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Architect, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.
7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
8. 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.
9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
10. Install raceways:

    a. To meet the requirements of the structure and the requirements of all other Work on the Project.
    b. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
    c. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
    d. Parallel or perpendicular to building lines or column lines.
    e. Tight to structure.
    f. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

11. Raceways Embedded in Slabs:

    a. Raceways may only be embedded in concrete slabs with written permission from, and only where directed, by the Structural Engineer.
    b. Install in middle 1/3 of slab thickness, where practical. At a minimum, concrete shall provide at least 2 inches of concrete cover for raceways.
    c. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
    d. Space raceways laterally to prevent voids in concrete.

e. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
f. Change from RNC to coated GRS or IMC before rising above the floor.

12. Where masonry walls are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.
13. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section “Hangers and Supports for Electrical Systems”. Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.

    a. Raceways on roof shall be supported from structure not from the roof deck.

14. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:

    a. Attach single raceway directly to structural steel with beam clamps.
    b. Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.
    c. Attach groups of raceway to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.
    d. Attach groups of raceway to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.
    e. Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.
    f. Hang horizontally suspended groups of raceway using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.
    g. Support conductors in vertical raceway in accordance with NFPA 70 requirements.
    h. Cross-brace suspended raceway to prevent lateral movement during seismic activity.
    i. Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.

15. Install electrically- and physically-continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flaking the finish.
16. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Architect’s approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.
17. Align and install raceway terminations true and plumb.
18. Complete raceway installation before starting conductor installation.
19. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

20. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints; or where structures providing a means of support are subject to relative movement greater than acceptable by the raceway manufacturer.
21. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.
22. Install raceway sealing 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:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.
    b. Where otherwise required by NFPA 70.

23. 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 finished floor. Extend conductors to equipment with as indicated; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
24. Maintain 2” minimum spacing from bottom of roof deck to prevent raceway penetrations from above
25. Do not route conduits across skylights, access panels, hatched tiles, HVAC diffusers, or equipment working space.
26. Route conduits serving rooftop equipment concealed inside the equipment curb and minimize roof penetrations and exterior conduit runs where practicable.
27. Install all underground conduits/raceways a minimum of 24” below the bottom of slab/paving/grade, unless noted otherwise, where practicable.
28. Provide boxes and raceways for the fire protection system low voltage wiring as required. This includes low voltage wiring exposed less than 96” AFF.

    a. At a minimum, provide 3/4” conduit.
    b. Coordinate requirements and locations with system installer and fire alarm specifications.

B. RMC

1. Use GRS or IMC in the following areas:

    a. Where indicated.
    b. Exterior applications where above grade and exposed.
    c. Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.
    d. All raceways penetrating slabs on grade (use plastic-coated raceway or provide with a corrosion resistant approved mastic coating). This shall include the 90-degree elbow below grade and the entire vertical transition to above grade.
    e. Conductors over 600 volts.
    f. Concealed within masonry walls.
    g. Damp or wet locations.
    h. Interior spaces where exposed to damage. Includes but is not limited to the following areas.

        1) Loading dock
        2) Corridors used for traffic of mechanized carts, forklifts and pallet handling units.

2. Use RAC in the following areas:

    a. Indoors above grade.
    b. Interior wet or damp locations.

3. Do not use RAC:

    a. Below grade.
    b. Imbedded in concrete or other areas corrosive to RAC.

C. EMT

1. Use EMT in the following areas:

    a. Where indicated.
    b. Interior concealed locations for:

        1) Branch circuits.
        2) Feeders.
        3) Low-voltage control, security, and fire alarm circuits

    c. Exposed where not subject to physical damage

        1) Mechanical rooms

2. Do not use EMT:

    a. Below grade.
    b. In exterior applications when exposed.

D. FMC and LFMC

1. Use FMC or LFMC:

    a. For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.
    b. From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.
    c. Use FMC only in dry locations.
    d. Use LFMC in damp, wet, corrosive, outdoor locations.

2. Do not use FMC or LFMC:

    a. For branch circuits, homeruns or feeders.
    b. In lengths exceeding 6 feet.

E. RNC

1. Solvent-weld RNC fittings and raceway couplings per the manufacturer’s instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.
2. Where installed exposed outdoors or other areas subject to temperature variations, install expansion fittings per Article 352.44 of NFPA 70, to accommodate thermal expansion in straight runs.
3. RNC is only allowed to be used in the following locations:

a. Where specifically indicated.

1) If an adopted code prevents use of RNC in a location where the contract documents specifically allows its use, contractor shall utilize other types of conduit allowed by the specification.
2) Allowed does not mean required.

4. Underground, single and grouped, in lieu of GRS or IMC, when indicated.

a. Direct buried
b. Concrete-encased (use approved rigid PVC interlocking spacers, selected to provide minimum duct spacing and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts).

F. Telephone and Signal/Data System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

3.3 RACEWAY FITTINGS:

A. Compatible with raceways and suitable for use and location.

B. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.

C. PVC Externally Coated, Rigid Steel Conduits: Use only fittings and installation tools approved by the manufacturer for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits. Replace all fittings and conduits that have any portion of the coating scraped off to bare metal, at no additional cost to the Owner.

D. Join raceways with fittings designed and approved for that purpose and make joints tight.

E. Use insulating bushings to protect conductors at raceway terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

3.4 WIREWAYS:

A. Use flat head screws, clips and straps to fasten wireways to surfaces. Mount plumb and level.

B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

C. Close ends of wireway and unused raceway openings.

3.5 BOXES

A. General

1. Verify locations of device boxes prior to rough in.

2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.
3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.
4. Install boxes to preserve fire ratings of walls, floors, and ceilings.
5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.
6. Support boxes independently of raceway.
7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.
8. Adjust flush-mounted boxes to make front edges flush with finished wall material.
9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.
10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.

B. NEMA Enclosure ratings: Suitable for the environment in which it is installed. At a minimum, provide the following ratings:

1. NEMA 250, type 3R

    a. Provide at exterior locations

2. NEMA 250, type 1

    a. Provide at interior and dry locations

3. NEMA 250 type 4 stainless steel

    a. Provide at interior damp or wet locations
    b. Provide at interior locations where associated device is labeled as Weather Proof and/or Weather Resistant, unless requirement below already requires box to be rated otherwise.

C. Outlet Boxes

1. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Contract Administrator. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.
2. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.
3. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
4. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
5. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
6. Use cast aluminum boxes where aluminum rigid metal conduit is used.

7. Use nonmetallic boxes where exposed rigid PVC conduit is used.
8. Use suitable concrete type boxes where flush-mounted in concrete.
9. Use suitable masonry type boxes where flush-mounted in masonry walls.
10. Use raised covers suitable for the type of wall construction and device configuration where required.
11. Use shallow boxes where required by the type of wall construction.
12. Install extension and plaster rings as required by NFPA 70.
13. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.
14. Do not exceed allowable fill per NFPA 70.
15. Where multiple devices are shown grouped together, gang mount with a common cover plate.

D. Junction and Pull Boxes

1. Install junction and pull boxes above accessible ceilings and in unfinished areas.
2. Provide boxes set flush in painted walls or ceilings with primer coated cover.
3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.
4. Boxes for exterior use shall be:

   a. PVC with a UV-stabilized PVC cover sealed and gasketed watertight.
   b. Cast aluminum with a cast aluminum cover sealed and gasketed watertight.
   c. Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.
   d. Install buried boxes so that box covers are flush with grade, unless indicated otherwise.

3.6 CABINETS AND ENCLOSURES

A. Unless otherwise indicated on the Drawings, provide

1. NEMA 1 construction for indoor, dry locations
2. NEMA 12 for indoor, damp and dusty locations
3. NEMA 3R for outdoor locations

B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.

C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.

D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.

E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.

F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for

the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

3.7 IDENTIFICATION

A. Refer to Division 26 Section “Identification for Electrical Systems” for identification materials.

B. Raceway Identification:

1. Conduit and raceways are to be color coded for ease of identification. Where a facility standard already exists, that shall be followed. Where no standard exists for color-coding, provide in accordance with table below.

a. Conduit shall be color-coded from the factory. Junction boxes, fittings, and connectors are not required to be painted to match.
b. As an alternative, submit deduct to omit use of factory-painted conduit. Tape or paint are to be used to identify conduits and junction boxes and/or fittings are to be painted in accordance with facility standard or color table.

Conduit Service	**Color Description**
Building Automation and Controls	Blue
Fire Alarm	Red
Life Safety (Emergency) Power Branch	Yellow

2. 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. Use the following means of identification:

a. Self-Adhesive Vinyl Labels

3. Color for Printed Legend:

a. Power Circuits: Black letters on an orange field.
b. Legend: Indicate system or service and voltage, if applicable

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identification device shall be:

1. Self-adhesive vinyl label

D. Accessible Raceways of Auxiliary Systems: Identify the following systems using the same identification device as other accessible raceways 600V or less, and with the indicated color scheme for each system:

1. Fire Alarm System: Red.
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Combined Fire Alarm and Security System: Red and blue.
4. Security System: Blue and yellow.
5. Mechanical and Electrical Supervisory System: Green and blue.
6. Telecommunication System: Green and yellow.
7. Control Wiring: Green and red.

E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

F. Junction Boxes and Pull Boxes:

1. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.
2. The junction box where a homerun ends and the circuit is distributed shall be marked. Junction boxes shall be marked approximately every 100 feet along homerun path to panel.

END OF SECTION 260533

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SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. Raceways, fittings, boxes for underground electrical site distribution

B. Hand holes and pull boxes

C. Manholes

D. Components for direct buried electrical distribution

E. Components for concrete-encased electrical distribution

1.2 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. GRS: Galvanized Rigid Steel Conduit
2. RMC: Rigid Metal Conduit
3. RNC: Rigid Nonmetallic Conduit
4. RTRC: Reinforced Thermosetting Resin Conduit

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
2. Coordinate elevations of ducts and duct-bank entrances into manhole, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Contract Administrator.

1.4 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
2. Marked for intended use.

C. Comply with NFPA 70 and ANSI C2.

D. Test and inspect pre-cast concrete utility structures according to ASTM C 1037.

E. Non-concrete Handhold 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 a independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the 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.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.

B. Store pre-cast and other factory –fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.

C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

1.6 PROJECT CONDITIONS

A. Interruption of existing electrical service to occupied facilities shall not occur unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated.

1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architects written permission.

PART 2 - PRODUCTS AND MATERIALS

2.1 RACEWAYS AND FITTINGS

A. Metal Conduit

1. Manufacturers:

a. ABB, Inc.
b. Atkore
c. Nucor Tubular Products.
d. O-Z/Gedney Co.; Emerson.
e. Western Tube and Conduit Corporation.
f. Wheatland Tube Co.

2. RMC:

a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6

3. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.40 inches (1 mm), minimum.
4. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Manufacturers:

    a. ABB, Inc.
    b. American Pipe and Plastics, Inc.
    c. Anamet Electrical, Inc.;
    d. Atkore
    e. Cantex Inc.
    f. Carlon
    g. Champion Fiberglass, Inc.
    h. IPEX USA, LLC.
    i. Prime Conduit.
    j. Southwire Corporation.
    k. Superflex Ltd.
    l. United Fiberglass of America, Inc.

2. RNC: Schedule 40 (type EPC-40-PVC) PVC: NEMA TC 2, UL 651.

    a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.

3. RTRC: UL 2420 UG NEMA TC 14 SW (Standard Wall), HW (Heavy Wall) or XW (Extra Heavy Hall)

C. DUCT ACCESSORIES

1. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Underground-line warning tape specified in Division 26 Section “Identification for Electrical Systems.”
3. Concrete warning planks shall be nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

    a. Color: Red dye added to concrete during batching.
    b. Labeling: Mark each plank with “ELECTRICAL” in 2-inch high, 3/8-inch deep letters.

2.2 PRE-CAST CONCRETE HANDHOLES AND BOXES

A. General

1. Manufacturers:

    a. Carder Concrete Products.
    b. Christy Concrete Products
    c. Elmhurst-Chicago Stone Co.
    d. Oldcastle Pre-cast Group
    e. Riverton Concrete Products; a division of Cretex Companies, Inc.
    f. Utility Concrete Products, LLC
    g. Utility Vault Co.
    h. Wausau Title, Inc.

B. Comply with ASTM C858 for design and manufacturing process.

C. Pre-cast concrete handholes and boxes shall be 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 the handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

4. Frame and Cover: Weatherproof aluminum frame, with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

5. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.
6. The cover shall have the following legend lettering molded into the cover:

    a. “COMMUNICATIONS”
    b. “CONTROLS”
    c. “ELECTRICAL”
    d. “FIBER OPTICS”
    e. “LIGHTING”

7. Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
8. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.

    a. Extension shall provide increased depth of 12 inches.
    b. Slab shall be same dimensions as bottom of enclosure, and arranged to provide closure.

9. Windows shall be included as pre-cast openings in walls arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

    a. Windows 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.
    b. Window openings shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.

10. Duct entrances into handhole walls shall have cast end-bell or duct–terminating fittings in the wall for each entering duct.

    a. Type and size shall match fittings to duct or conduit to be terminated.

b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

11. 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.

2.3 HANDHOLES AND BOXES OTHER THAN PRE-CAST CONCRETE

A. General

1. Description: Comply with SCTE 77.
2. Color of Frame and Cover: Gray where installed in concrete or other paved area; Green where installed in grass area.
3. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated..
4. Load Ratings:

a. Boxes and covers installed in sidewalks and other areas not subject to normal vehicular traffic shall be rated for a design load of 8,000 lbs. minimum.
b. Boxes and covers installed in driveways, parking lots, and other off-roadway applications shall be rated for a design load of 15,000 lbs. minimum.
c. Boxes and covers installed in roadways and other high vehicular traffic areas shall be rated for a design load of 28,800 lbs.

5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, applicable logo from the following:

a. “COMMUNICATIONS”
b. “CONTROLS”
c. “ELECTRIC”
d. “FIBER OPTICS”
e. “LIGHTING”

8. Duct Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
9. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pullin-in irons.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis.
e. Strongwell

C. Fiberglass Handholes and Boxes with Polymer-Concrete frame and cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armorcast Products Company.
    b. Carson Industries LLC.
    c. Christy Concrete Products.
    d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carson Industries LLC.
    b. Christy Concrete Products.
    c. Nordic Fiberglass, Inc.

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene of copolymer-polypropylene. Cover shall be polymer concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carson Industries LLC.
    b. Nordic Fiberglass, Inc.
    c. PenCell Plastics

2.4 PRE-CAST MANHOLES

A. Pre-cast-concrete manholes shall be furnished in sizes as indicated on the plans and as specified herein. Pre-cast manholes shall be constructed of reinforced concrete, complete with all appurtenances and accessories required.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carder Concrete Products.
    b. Christy Concrete Products.
    c. Elmhurst-Chicago Stone Co.
    d. Oldcastle Pre-cast Group.
    e. Riverton Concrete Products; a division of Cretex Companies, Inc.
    f. Utility concrete Products, LLC.
    g. Utility Vault Co.
    h. Wausau Tile, Inc.

B. Comply with ASTM C858, with structural design loading as specified in Part 3 “Underground enclosure Application” and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Pre-cast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches form interior surfaces of walls, floors, or roofs of manholes, but close enough to facilitate racking of cables on walls.
b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
c. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.
b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

C. Concrete Knockout Panels: 1-1/2 to 32 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 CAST-IN-PLACE MANHOLES

A. Description: underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for concrete entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C858 and with Division 03 Section “Cast-In-Place Concrete.”

2.6 UTILITY STRUCTURE ACCESSORIES

A. Utility structures shall be installed complete including accessories as listed below.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

a. Bilco Company (The).
b. Campbell Foundry Company.
c. Carder Concrete Products
d. Christy Concrete Products.
e. East Jordan Iron Works, Inc.
f. Elmhurst-Chicago Stone Co.
g. McKinley Iron Works, Inc.
h. Neenah Foundry Company.
i. NewBasis
j. Oldcastle Precast Group
k. Osburn Associates, Inc.
l. Pennsylvania Insert Corporation.
m. Riverton concrete Products; a division of Cretex Companies, Inc.
n. Strongwell Corporation; Lenoir City Division.
o. Underground Devices, Inc.
p. Utility Vault Co.
q. Wausau Tile, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
b. Special Covers: recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

a. “CATV”
b. “COMMUNICATIONS”
c. “CONTROLS”
d. “ELECTRIC”
e. “FIBER OPTIC”
f. “LIGHTING”

3. Manhole Chimney Components: Pre-cast concrete rings with dimensions matching to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2 inch diameter eye, and 1 by 4 inch bolt.

1. Working load embedded in 6 inch, 4000-psi concrete is 13,000-lbf maximum tension

E. Pulling Eyes in Non-concrete Walls: Eyebolt with reinforced fastening, 1-1/4 inch diameter eye, rated 2500-lbf minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8 inch diameter, hot-dip galvanized, bent rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

G. Bolting Inserts for concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of non-corrosive, chemical-resistant, non-conductive thermoplastic material; ½-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000-lbf minimum.

H. Expansion Anchors for Installation after Concrete is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with ½-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

I. Cable Rack Assembly: Steel, hot-rolled galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2 inch centers for cable-arm attachment.
2. Arms: 1-1/2-inches wide, lengths ranging from 3-inches with 450-lb minimum capacity to 18-inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

J. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36-inches high by 4-inches wide, with minimum of 9 holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3-inches with 450-lb minimum capacity to 20-inches with 250-lb minimum capacity. Top of arm shall be nominally 4-inches wide, and shall have slots along length for cable ties.

K. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

L. Fixed Manhole Ladders: Arranged for attachment to [roof] [or] [wall] [and floor] of manhole. Ladder and mounting brackets and braces shall be fabricated from [nonconductive, structural-grade, fiberglass-reinforced resin] [hot-dip galvanized steel].

M. Cover Hooks: Heavy duty, design for lifts 60-lbf and greater. Two required.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

3.2 UNDERGROUND ENCLOSURE INSTALLATION

A. Handholes and Boxes for 600 volts and Less ,Including Telephone, Communications, and Data Wiring:

1. Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 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.

B. Manholes: Pre-cast or Cast-in-Place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-80 or RTRC HW or XW PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 volts and Less: RNC, NEMA Type EPC-40 or RTRC SW or HW PVC, in direct- buried duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40 or RTRC SW or HW PVC, indirect-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC, in concrete-encased or direct-buried duct bank, unless otherwise indicated.

E. Underground Ducts Crossing Walks and Driveways: RNC, NEMA Type EPC-40 PVC or RTRC, encased in reinforced concrete.

3.4 EARTHWORK

A. Excavation and Backfilling: Comply with Division 31 Section “Earth Moving” but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections “Turf and Grasses and “Plants”

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section “Cutting and Patching.”

3.5 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48-inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer’s written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10-inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell with out reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit 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 duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section ”Common Work Results for Electrical.”

F. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

G. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and ducts to prevent floating during concreting. Stagger separators approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the ducts or duct group.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to the manufacturer’s written recommendations, 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 ¾-inch reinforcing rod dowels 18-inches into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured with out soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3-inches between ducts and exterior envelope wall, 2-inches between ducts for like services, and 4-inches between power and signal ducts.
7. Depth: Install top of duct bank 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 of vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
b. Stub-ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches above all concrete–encased ducts and duct banks. Align tape parallel to and within 3-inches of the 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.

I. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6-inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section “Earth Moving” for pipes less than 6-inches in nominal diameter.
4. Install backfill as specified in Division 31 Section “Earth Moving.”
5. After installing first tier of ducts, 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 backfill to 4-inches over ducts 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 run and complete backfilling with normal compaction as specified in Division 31 Section “Earth Moving.”
6. Install ducts with a minimum of 3-inches between ducts for like services and 6-inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36-inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.

10. Warning Planks: Bury warning planks approximately 12 inches above all direct-buried ducts an duct banks placing them 24-inches 0.c.. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional planks 12-inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for future duct connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.

3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section “Cast-in-Place Concrete.”

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts 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.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15-inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1-inch above finished grade.
3. Install handholes with bottom below the frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1-inch above grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. 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 frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. 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 Division 07 Section “Elastomeric Sheet Waterproofing.” After ducts have 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

G. 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 Division 07 Section “Bituminous Damp proofing”.” After ducts have been 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.

H. Hardware: Install removable hardware, including pulling eye, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items n manholes.

J. Field-Installed Bolting Anchors in 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.

K. Warning Sign: Install “Confined Space Hazard” warning sign on the inside surface of each manhole cover.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRE-CAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000psi, 28-day strength, complying with Division 03 Section “Cast-in-Place Concrete,” with a troweled finish.
2. Dimensions: 10-inch wide by 12-inches deep.

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

3.9 INSTALLATION ACCEPTANCE

A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum of wood test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct. Test duct bank and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section “Grounding and Bonding for Electrical Systems.” Correct any deficiencies and retest as specified above. Clean internal surfaces of handholes and remove foreign materials.

END OF SECTION 260543

SECTION 260548 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. This section includes general seismic requirements specific other sections of the Division 26 specifications.

1.2 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.3 SUMMARY

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 20 Section “Seismic Controls for MEP/F/T Systems”.

B. The following equipment shall withstand the effects of earthquake motions. The equipment will remain in place without separation of any parts from the device when subjected to the seismic forces specified:

1. Panelboards used in normal power systems
2. Raceways and Boxes used in normal power systems
3. Low-Voltage Transformers used in normal power systems
4. Switchboards used in normal power systems
5. Panelboards used in normal power systems

PART 2 - PRODUCTS AND MATERIALS
(Not Used)

PART 3 - EXECUTION
(Not used)

END OF SECTION 260548

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Nameplates
2. Labels for raceways and metal-clad cable.
3. Labels for junction boxes and pull boxes.
4. Labels for wiring devices and lighting control devices.
5. Markers for conductors, and control cables.
6. Tags.
7. Underground-line warning tape.
8. Warning labels and signs.
9. Arc Flash Warning Labels.
10. Instruction signs.
11. Miscellaneous identification products.
12. Painted Identification.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.

B. 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.

C. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

D. Coordinate installation of identifying devices with location of access panels and doors.

E. Install identifying devices before installing acoustical ceilings and similar concealment.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.
2. Marked for intended use.

B. Comply with ANSI A13.1 and ANSI C2.

C. Comply with NFPA 70.

D. Comply with 29 CFR 1910.145.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Location, text, and method of identification to be used is noted in individual sections. Refer to related sections for additional identification requirements.

2.2 NAMEPLATES

A. Comply with UL RP 9691, Recommended Practice for Nameplates for Use in Electrical Installations.

B. Engraved, Laminated Acrylic or Melamine Label: Non-conductive phenolic with beveled edges.

1. Adhesive backed.
2. Minimum 1/16 inch (1.6 mm) thick for nameplates with both dimension 4 inches (102 mm) or less and 1/8 inch (3.2 mm) thick for larger sizes.

C. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.

D. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text

E. Text: Minimum text height shall be 1/8 inch (3.2 mm) unless otherwise required by local jurisdiction or owner standards. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.

F. Colors:

1. Normal systems - white letters on a black background.
2. Emergency systems - white letters on a red background.

G. Label Requirements:

1. Service Equipment Label
   LINE 1: NOMINAL VOLTAGE AND FREQUENCY IN HERTZ
   LINE 2: SERVICE EQUIPMENT BUS RATING IN AMPS
   LINE 3: SCCR OF SERVICE EQUIPMENT IN AMPS
   LINE 4: MAXIMUM AVAILABLE FAULT CURRENT IN AMPS
   LINE 5: DATE CALCULATED

   EXAMPLE:

   208Y/120V, 60HZ
   800A
   SCCR = 65,000A
   MAX AVAILABLE FAULT CURRENT = 58,815A
   CALCULATED: 01/01/2018

2. Panelboard/Switchboard Label:
   LINE 1: PANELBOARD/SWITCHBOARD DESIGNATION
   LINE 2: VOLTAGE, PHASE, WIRES, AMPS
   LINE 3: FED FROM “ “

   EXAMPLES:

H1A
480Y/277V, 3PH, 4W, 200A
FED FROM MDB

L1A
208Y/120V, 3PH, 4W, 225A
FED FROM H1A VIA XFMR T1

3. Transformer Label:
   LINE 1: TRANSFORMER DESIGNATION
   LINE 2: FED FROM “ “
   LINE 3: SUPPLIES “ “

   EXAMPLE:

   T1
   FED FROM H1A
   SUPPLIES L1A

4. Disconnect Switch Label:
   LINE 1: DESIGNATION OF EQUIPMENT SERVED BY DISCONNECT
   LINE 2: VOLTAGE, PHASE, WIRES, AMPS
   LINE 3: FED FROM “ “

   EXAMPLES:

   WATER HEATER WH1
   480V, 3PH, 3W, 100A
   FED FROM MDB

2.3 LABELS FOR RACEWAYS AND METAL-CLAD CABLE

A. Factory Painted Raceways:

   1. Metal Raceways: Continuous, rust-inhibiting paint factory applied.
   2. Non-Metallic Raceways: Factory dyed or colored PVC sleeve.

B. Factory Painted Metal-Clad Cable: 2-inch wide, factory painted bands at a maximum of 6-foot on center spacing.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.4 LABELS FOR JUNCTION BOXES AND PULL BOXES

A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.5 LABELS FOR WIRING DEVICES AND LIGHTING CONTROL DEVICES

A. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

B. Permanent Ink: Permanent, waterproof, black ink marker, hand printed legibly.

2.6 MARKERS FOR CONDUCTOR AND CONTROL CABLES

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

D. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

2.7 TAGS

A. Write-On Tags: Polyester tag, 0.010 inch (0.25 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.8 UNDERGROUND-LINE WARNING TAPE

A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Foil-backed Detectable Type Tape: 6 inches (152 mm) wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color: Tape for Buried Power Lines: Black text on red background.

2.9 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.

B. Self-Adhesive Warning Labels: Factory pre-printed or machine-printed multicolor self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

1. Use thermal transfer process printing machines and accessories recommended by label manufacturer.
2. Do not use labels designed to be completed using handwritten text.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

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 (208 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."
3. Workspace Clearance Warning (480 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (915 MM)."

2.10 ARC FLASH WARNING LABELS

A. General: All labels will be based on recommended overcurrent device settings and will be printed after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system. Refer to Division 26 section “Overcurrent Protective Device Study” for additional requirements.

B. Materials: Use machine-printed, high adhesion, polyester label; UV, chemical, water, heat, and abrasion resistant, for each work location analyzed.

C. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer. Labels shall be machine printed, with no field markings. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

D. Minimum Size: 3.5 inch by 5 inch (89 mm by 127 mm), unless otherwise noted by Owner.

E. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Available fault current
4. Limited approach boundary
5. Arc flash boundary
6. Restricted approach boundary
7. Hazard risk category
8. Incident energy
9. Working distance
10. Site-specific PPE (personnel protective equipment) requirements.
11. Date calculations were performed.
12. Engineering report number, revision number and issue date.

2.11 INSTRUCTION SIGNS

A. Engraved, Laminated Acrylic or Melamine plastic: Non-conductive phenolic. Unless indicated otherwise, provide with minimum 3/8-inch- (10-mm-) high letters. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.

1. Minimum 1/16 inch (1.6 mm) thick for nameplates with either dimension greater than 4 inches (102 mm) and 1/8 inch (3.2 mm) thick for larger sizes.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
4. Normal systems: Engraved legend with white letters on black face.
5. Essential Systems: Engraved legend with white letters on red face.

B. Stainless Steel Nameplates: Minimum thickness of 1/32 inch ; engraved or laser-etched text.

C. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text

D. Colors:

1. General Information and Operating Instructions – Black letters on white background.
2. Normal systems - white letters on a black background.
3. Emergency systems - white letters on a red background.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Fasteners for Nameplates, Labels and Signs

1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

C. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

2.13 PAINTED IDENTIFICATION

A. Paint materials and application requirements are specified in Division 09 painting Sections.

1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):

a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Exterior concrete and masonry primer.
2) Finish Coats: Exterior semi-gloss acrylic enamel.

2. Exterior Concrete Unit Masonry:

a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.

1) Block Filler: Concrete unit masonry block filler.
2) Finish Coats: Exterior semi-gloss acrylic enamel.

3. Exterior Ferrous Metal:

a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Exterior ferrous-metal primer.
2) Finish Coats: Exterior semi-gloss alkyd enamel.

4. Exterior Zinc-Coated Metal (except Raceways):

a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Exterior zinc-coated metal primer.
2) Finish Coats: Exterior semi-gloss alkyd enamel.

5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):

a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Interior concrete and masonry primer.
2) Finish Coats: Interior semi-gloss alkyd enamel.

6. Interior Concrete Unit Masonry:

a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.

1) Block Filler: Concrete unit masonry block filler.
2) Finish Coats: Interior semi-gloss acrylic enamel.

7. Interior Gypsum Board:

a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

1) Primer: Interior gypsum board primer.
2) Finish Coats: Interior semi-gloss acrylic enamel.

8. Interior Ferrous Metal:

    a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

        1) Primer: Interior ferrous-metal primer.
        2) Finish Coats: Interior semi-gloss acrylic enamel.

9. Interior Zinc-Coated Metal (except Raceways):

    a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

        1) Primer: Interior zinc-coated metal primer.
        2) Finish Coats: Interior semi-gloss acrylic enamel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify identity of each item before installing identification products.

B. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

C. Provide identification product listed for the location in which it is to be installed.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Painted Identification: Prepare surface and apply paint according to Division 09 painting sections.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. For surfaces that require finish work, apply identification devices after completing finish work.

C. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed. Replace labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

D. Location: Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance without interference with operation and maintenance of equipment. Unless otherwise indicated, locate products as follows:

1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Branch Devices: Adjacent to device.
6. Interior Components: Legible from the point of access.
7. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.

9. Conductors and Cables: Legible from the point of access.
10. Devices: Outside face of cover.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

1. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

G. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual

1. Indoor Clean, Dry Locations: Use plastic nameplates, unless noted otherwise.
2. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.

H. Install identification products centered, level, and parallel with lines of item being identified.

I. Mark all handwritten text, where permitted, to be neat and legible.

J. For refrigeration systems: Neatly bundle circuits and clearly tag and label each circuit with panelboard, branch circuit designation and refrigeration system number at each termination.

END OF SECTION 260553

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SECTION 260573 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes computer-based studies for the following:

1. Short-circuit analysis.
2. Protective device coordination study.
3. Arc flash and shock risk assessment, including arc flash hazard labels.

B. Criteria for selection and adjustment of equipment and associated protective devices not specified in this section, as determined by the studies performed.

1.2 ADMINISTRATIVE REQUIREMENTS

A. The AIC ratings indicated on the Drawings are preliminary and will be finalized based on the results of the short-circuit study. Device ratings for furnished equipment shall be as required by the results of the short-circuit study at no additional cost.

B. Coordination:

1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
3. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

C. Pre-Study Meeting: Conduct meeting with Owner to discuss system operating modes and conditions to be considered in studies.

D. Sequencing:

1. Initial Study:

a. Study must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. Do not order equipment until matching study reports and product submittals have both been evaluated by the Contract Administrator.
b. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the Contractor at no additional cost to the project.

2. Final Study:

a. Study must be completed and submitted for review prior to substantial completion. Do not print arc flash labels until final study has been evaluated by the Contract Administrator.
b. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels.

E. Scheduling:

1. Arrange access to existing facility for data collection with Owner.
2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner. Refer to Division 26 section “General Electrical Requirements” for additional requirements.

1.3 SUBMITTALS

A. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.

1. Product data for computer software program to be used for studies.
2. Include characteristic time-current trip curves for protective devices.
3. Identify modifications made in accordance with studies to meet the results of the study.

B. Product Certificates: For coordination-study and short-circuit-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data:

1. Study Preparer Specialist qualifications.
2. Field Testing Agency qualifications.

D. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

E. Other Action Submittals:

1. Initial Study report, stamped or sealed and signed by study preparer, including:

a. Cover page including date of study, study methodology, assumptions made and software products used.
b. Study input data, including completed computer program input data sheets.
c. Short-circuit study report.
d. Equipment evaluation report.
e. Coordination-study report.
f. Settings report.

2. Final Study report, stamped or sealed and signed by study preparer, including:

a. Cover page including date of study, study methodology, assumptions made, software products used, and summary of changes between initial and final studies.
b. Study input data, including completed computer program input data sheets.
c. Short circuit study report.
d. Equipment evaluation report.
e. Coordination-study report.
f. Settings report.
g. Arc-Flash Hazard Analysis, including labels.

3. Certification that field adjustable protective devices have been set in accordance with requirements of studies.

F. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.
2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.
3. Include copies of previous studies and existing drawings that were obtained during the data collection phase of the study.

1.4 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. Study Preparer Qualifications: An organization 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 in which the Project is located, shall be responsible for the study and with a minimum five years experience in the preparation of studies of similar type and complexity using the specified computer software. 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 IEEE 242 for short-circuit currents and coordination time intervals.

E. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard calculations.

F. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.

1. Field Supervisor: Certified electrical testing technician; NETA ETT Level III.

PART 2 - PRODUCTS AND MATERIALS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:

1. CYME International, Inc. (Eaton): www.cyme.com.
2. EasyPower – Part of Bentley Systems: www.easypower.com.
3. ETAP/Operation Technology, Inc: etap.com.
4. Power Analytics Corporation: www.poweranalytics.com.
5. SKM Systems Analysis, Inc: www.skm.com.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of Short-Circuit-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

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.

1. Zero-Sequence current.
2. Arcing faults.

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. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

C. Fault current study and coordination study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.

D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project’s utility company confirms the available fault current. A final coordination study with all device settings shall be submitted with the Arc Flash Study. The goal of the revised settings is to minimize the arc flash hazard while maintaining reasonable coordination and selectivity. For the components of emergency and legally required standby system components, full selectivity must be maintained.

3.2 SYSTEM COMPONENTS TO BE INCLUDED IN STUDIES

A. Study shall begin with the utility and each alternate power source overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device. This includes studies of the complete paths on both sides of any transfer switch, contactor or circuit breaker.

B. Components include, but are not limited to:

1. Switchboards
2. Distribution Panelboards
3. Panelboards
4. Air Handling Equipment
5. Roof Top HVAC equipment

3.3 POWER SYSTEM DATA FOR STUDIES

A. Gather and tabulate the following input data to support studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and 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.

2. Impedance of utility service entrance.
3. Electrical distribution system diagram showing the following:

    a. Indicate load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
    b. Protective Devices: Include circuit-breaker and fuse-current ratings and types;
    c. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
    d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio. kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    e. Cables: Indicate conduit material, sizes of conductors, conductor insulation, and length.
    f. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Magnetic inrush current overload capabilities of transformers.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Ratings, types, and settings of utility company's overcurrent protective devices.
    e. Special overcurrent protective device settings or types stipulated by utility company.
    f. Protective Devices:

        1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
        2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).

    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 ratings in amperes rms symmetrical.

5. Existing Installations:

    a. Provide the services of field testing agency or equipment manufacturer's representative to perform field data collection.
    b. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.

3.4 SHORT-CIRCUIT STUDY

A. Source Impedance: Utility company's fault-current contribution as indicated.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
2. Low-Voltage Fuses: IEEE C37.46.
3. Circuit Breakers: IEEE C37.13.

F. Study Report:

1. Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
3. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

G. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.5 COORDINATION STUDY

A. Perform coordination study and prepare a written report using the results of Short-Circuit study and approved computer software program. Comply with IEEE 399.

B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

C. Comply with IEEE 241 recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

E. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

F. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

G. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings 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.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve the level of selective coordination required in the contract documents or by the edition of the National Electrical Code (including any local jurisdiction amendments) the project must comply with. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:

   a. For protective Devices:

      1) Device tags.
      2) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
      3) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
      4) Include ground fault pickup and delay.
      5) Include fuse ratings.

   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

3. Include conclusions and recommendations.
4. Completed data sheets for setting of overcurrent protective devices.
5. For emergency, legally required standby and health care essential power systems, such systems must selectively coordinate to the values indicated below unless local amendments to the National Electrical Code require a different value.

   a. Emergency (NEC article 700) 0.01 seconds

3.6 ARC-FLASH HAZARD ANALYSIS

A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies in accordance with IEEE 1584. Perform the analysis under worst-case arc-flash conditions for all modes of operation.

B. In addition to the requirements outlined in IEEE 1584, the study shall include all equipment rated less than 240 Volts fed by transformers less than 125 kVA in the calculations.

1. Where reasonable, study preparer may assume a maximum clearing time of two seconds in accordance with IEEE 1584, provided that the conditions are such that a worker's egress from an arc flash event would not be inhibited.
2. For single-phase systems, the calculations may be performed assuming a three-phase system in accordance with IEEE 1584, yielding conservative results.

C. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.

D. Identify all locations and equipment to be included in the arc-flash hazard analysis:

1. Include a copy of the facility one-line in the report.
2. Identify the possible system operating modes including tie-breaker positions, and parallel generation.
3. Calculate the arcing fault current flowing through each branch for each fault location.
4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.
5. Select the working distances based on system voltage and equipment class.
6. Calculate the incident energy at each fault location at the prescribed working distance.
7. Determine the hazard/risk category (HRC) for the estimated incident energy.
8. Calculate the flash protection boundary at each fault location.
9. Document the assessment in reports and one-line diagrams.
10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.

E. Results of the arc-flash study shall be summarized in a final report containing the following:

1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.
2. Tabulations of the data used to model the system components and a corresponding one-line diagram.
3. Descriptions of the modes of operation evaluated and identification of the worst case scenario used to evaluate equipment ratings.
4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.
5. Required arc-flash labeling and placement of labels.
6. Conclusions and recommendations, including recommendations for reducing incident energy at locations where calculated maximum incident energy exceeds 8 calories per sq cm.

3.7 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

a. Verify that overcurrent protective devices meet parameters used in studies.

b. Adjust devices to values listed in study results.
c. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 100.7 and 100.8 in NETA ATS.

3.8 INSTALLATION

A. Install arc flash warning labels. Refer to Division 26 section Identification for Electrical Systems for additional requirements.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect and test protective devices in accordance with the NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Overcurrent protection devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies protective device settings have been adjusted in accordance with the requirements of the study. Include notation of conflicts with or deviations made from the studies or the contract documents, deficiencies detected, remedial action taken, and observations after remedial action.

3.10 TRAINING

A. Provide training for Owner’s personnel on electrical safety pertaining to arc flash and shock hazards.

B. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.

C. Provide minimum of eight hours of training performed by a representative of the entity performing the study.

END OF SECTION 260573

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SECTION 260800 - COMMISSIONING OF ELECTRICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. See Section 019113 - General Commissioning Requirements for Contractor's commissioning responsibilities and Commissioning Scope of Work, including a list of systems to be commissioned. Comply with requirements of Section 019113.

B. The Commissioning Authority (3PCx) directs and coordinates all commissioning activities as described in Section 019113.

1.02 RELATED REQUIREMENTS

A. Section 019113 - General Commissioning Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 OPERATION AND MAINTENANCE MANUALS

A. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.

B. See Section 017800 for additional requirements.

END OF SECTION

SECTION 260805 - ELECTRICAL QUALITY SPECIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical quality requirements for base building infrastructure. Equipment includes:

a. Distribution:

1) LV switchboards
2) LV switchgear
3) MV switchgear
4) Panelboards (Greater than or equal to 800A)
5) Distribution panels (Greater than or equal to 800A)
6) Motor control centers (MCC)
7) Busway/Busduct

b. Transformers:

1) Dry type and liquid filled
2) Medium voltage and low voltage

c. Power Generation & Supply:

1) Generators
2) Portable generator connection cabinet
3) EGEN/SGEN panel
4) Uninterruptable power supply (UPS)

d. Emergency electrical equipment

1) Automatic transfer switches (ATS)
2) Emergency Panelboards
3) Emergency Distribution panels
4) Uninterruptable power supply (UPS)
5) Emergency Cables
6) Other electrical distribution equipment downstream of ATS.

e. Disconnecting Means:

1) Air switches
2) SF6 switches
3) Vacuum circuit breakers
4) SF6 circuit breakers
5) Air circuit breakers, medium voltage
6) Power circuit breakers
7) Molded case circuit breakers

f. Protection and Controls:

1) Protective relays (Including SEL 751 arc flash relay)
2) Medium voltage surge protection devices
3) Instrument transformers (Current transformers, potential transformers, control power transformers).
4) Metering and communications

g. Other:

1) Low voltage cables
2) Medium voltage cables
3) Non-emergency automatic/manual transfer switches
4) Grounding systems

2. Electrical quality inspection and acceptance testing as performed by 3PTV. Note that equipment types and quantities to inspect and test will vary per project/program type.

B. Section Does Not Include:

1. Electrical commissioning requirements as outlined in “Design Criteria – 019113-General Commissioning Specification”.
2. MHE electrical equipment.
3. Utility owned electrical equipment.

1.2 Related Requirements:

1. Design Criteria – 019113-General Commissioning Specification.

B. Definitions:

1. Deficiency: See 019113-General Commissioning Specification for definition.
2. Functional Performance Testing: See 019113-General Commissioning Specification for definition.
3. Pre-Energization: Equipment is not energized and has no presence of voltage.
4. Post-Energization: Equipment is energized and has presence of voltage.
5. First Time Energization: Equipment is energized for the first time after equipment installation.
6. Pre-Functional Testing: See 019113-General Commissioning Specification for definition.
7. Pre-Launch Open, Clean, and Inspection: Due to the long durations of building work being completed after the equipment is energized with permanent power, there is risk of dust, dirt, and debris to penetrate into critical electrical infrastructure. The pre-launch open, clean, and inspection of critical electrical infrastructure is completed as near to project handover as possible to ensure equipment is in the optimal operating condition.
8. Site Specific: Specific to an Owner building or facility.

C. Abbreviations:

1. 3PCx: Third party commissioning provider
2. 3PTV: Third party testing vendor
3. A/E: Architect/Engineer
4. AFF: Above Fixed Floor
5. AFR: Arc Flash Relay
6. ATS: Automatic Transfer Switch
7. BTS: Build to Suit
8. CM: Construction Manager

9. CPT: Control Power Transformer
10. CT: Current Transformer
11. FPT: Functional Performance Test
12. GC: General Contractor
13. LOTO: Lock Out Tag Out
14. LV: Low Voltage
15. MSB: Main Switchboard
16. MTS: Manual Transfer Switch
17. MV: Medium Voltage
18. O&M: Operations and Maintenance
19. OEM: Original Equipment Manufacturer
20. PFT: Pre-Functional Test
21. PT: Potential Transformer
22. RAD: Remote Actuation Device
23. RME: Reliability, Maintenance, and Engineering
24. SPD: Surge Protection Device
25. UPS: Uninterruptable Power Supply

D. Applicable Parties:

1. Construction Manager (CM)
2. Design Team (AOR, EOR, Owner)
3. General Contractor (GC)
4. Reliability and Maintenance Engineering (RME)
5. Third Party Testing Vendor (3PTV)
6. Third Party Commissioning Provider (3PCx)

1.3 SUBMITTALS

A. Electrical acceptance testing forms and results to be stored in Owner Power dB database. Contact bax-ee-construction-quality@(owner).com for Power dB job creation, and Power dB vendor onboarding.

B. All GC and 3PTV submittals, as listed below, to be stored in BIM360. Contact project construction manager to gain access to BIM360 site specific project.

1. GC and 3PTV submittals:

a. GC and 3PTV construction schedule(s).
b. List of equipment to be inspected and tested.
c. Electrical test instruments and equipment: model number and calibration records.
d. Pre-functional testing checklists.
e. Electrical acceptance testing reports.
f. As-built drawings.
g. As-left device settings files and configuration files.
h. Port list and communications mapping list (Device, MAC addresses, IP addresses, MODBUS registers, IDF port number, etc.)
i. Deficiency & punch list report.
j. OEM literature (User manual, installation manual, etc.)
k. Warranty documentation.

C. 3PTV electrical acceptance testing final report to include the following sections:

1. Equipment list with equipment identification numbers.

2. Test set/instrument model number and calibration information.
3. Observations and recommendations.
4. Completed checklists.
5. PowerdB reports.
6. Test set reports with pass/fail results.
7. Deficiency & punch list items with resolutions.
8. Pictures and screenshots (Including, but not limited to, SEL device terminal window screenshots, switchboard internal pictures and switchboard external pictures.)
9. Red-line as built drawings.
10. As-left protective relay settings.
11. As-left metering device settings.
12. As-left electronic trip unit settings.
13. Port list and communication mapping for all tested devices.

D. Responsibilities:

1. General Contractor (GC)

a. Quality assurance and quality control of building electrical infrastructure.
b. Onboard and manage 3PTV. 3PTV to be selected based on Owner preferred vendor list. Reference section 002000 of the project design criteria for the preferred vendor list.
c. Create and manage GC, sub-contractors and 3PTV schedule.
d. GC to provide list of equipment to 3PTV to be inspected and tested.
e. Coordinate with CM and RME to gain access to PowerdB for recording of test results.
f. Coordinate with CM to gain access to BIM360 or Autodesk Construction Cloud for submittals.
g. Provide and coordinate permits, AHJ inspections, utility work, and LOTO procedures. Perform switching procedures and LOTO procedures.
h. Outage support.
i. Receive equipment shipment from OEM. Verify equipment is in accordance with owners' requirements and design documents. Identify non-conformances, log them in punch list and resolve them prior to equipment energization.
j. Complete pre-functional testing checklist.
k. Support electrical inspection and acceptance testing with 3PTV.
l. GC and 3PTV to obtain IP/Port list and communication specific information for relaying, protection and metering devices.
m. Equipment first time energization. Energization approval to be given by GC, CM, 3PTV, and 3PCx teams to ensure equipment has been installed, tested and commissioned and all parties agree on energizing relevant equipment.
n. Support functional performance testing with 3PTV.
o. Document non-conformances in deficiency punch list. Resolve punch list items prior to equipment energization.
p. Coordinate and support pre-launch open, clean and inspection.
q. Verify completion of all equipment installation, inspection and testing documentation.

2. Commissioning Provider (3PCx)

a. See 019113-General Commissioning Specification.

3. Construction Manager (CM)

a. See 019113-General Commissioning Specification.

b. Coordination and supervision of GC and 3PTV.
c. Provide Autodesk Construction Cloud and BIM360 database access and training materials.

4. Third Party Testing Vendor (3PTV)

a. Perform initial site walk to understand project requirements and construction progress. Verify equipment is ready for 3PTV scope of work and create inspection and testing schedule accordingly and submit to GC.
b. Prior to site mobilization: Gather drawings, documents, settings and configuration files with respect to scope of work from GC.
c. Coordinate with CM and RME to gain access to PowerdB for recording of test results.
d. Coordinate with CM to gain access to BIM360 or Autodesk Construction Cloud for submittals.
e. Coordinate with GC on switching procedures and LOTO procedures.
f. Complete electrical inspection and acceptance testing with GC.
g. Document non-conformances in deficiency punch list. Resolve punch list items prior to equipment energization.
h. Support pre-launch open, clean and inspection.

5. Reliability and Maintenance Engineering (RME)

a. Review inspection and testing documents from all parties and approve equipment handover from construction manager.

E. Quality Verification

1. GC to perform insulation resistance testing on all power cables pulled and supply test results to owner.
2. GC to torque and torque mark all electrical connections. GC to verify torque of OEM factory electrical connections. Torquing to be completed using a calibrated torque wrench or torque screwdriver. GC to supply torque sheet showing bolt size, required torque and actual torque.
3. For SEL 751 arc flash relay installations perform the following:

a. (GC to perform) [Applicable to retrofits. Implementation for BTS sites to be approved by Tenant] SEL 751 arc flash relay remote mounted installation:

1) Install control box with relay, and UPS. Arc Flash Relay should be installed with center of the screen at 5’7” AFF and as close as possible to the main breaker (<25ft). Ensure industry standard working space distances are adhered to. If this cannot be met, please notify Owner RME team prior to mounting.
2) Install conduit:

a) Two (2) one-inch conduit from relay panel to switchboard main breaker section.
b) One (1) one-inch conduit from relay panel to UPS box.

b. (3PTV to perform) SEL 751 arc flash relay inspection and testing for remote mounted and switchboard integrated installations:

1) Install interconnecting cables and perform point to point verification.
2) Install fiber optic cables.

3) Install communication cables to identified BMS point. Verify BMS is receiving required data.
4) Complete arc flash relay acceptance testing checklist. Refer to Appendix D.
5) 3PTV to verify metering quantities such as current and voltage are correct after energization of switchgear/switchboard. Identify non-conformances, log them in deficiency punch list and resolve them prior to handover of equipment to RME and operations.

4. For SEL 735 or PM8000 switchboard metering installations GC and 3PTV to verify the following:

a. 3PTV to obtain IP address for switchboard main metering from Owner IT.
b. 3PTV to complete main metering acceptance testing checklist. Refer to Appendix E.
c. GC to install communication cables to identified BMS point.

5. For switchboard integrated metering 3PTV to verify the following:

a. 3PTV to obtain IP address for switchboard integrated metering from Owner IT.
b. 3PTV to complete integrated metering acceptance testing checklist. Refer to Appendix F.
c. 3PTV to verify communications panel server or gateway is configured and is transmitting data from feeder circuit breakers back to the BMS. Verify BMS is receiving the required data.

6. All base building electrical distribution protective devices to be set and tested per the approved electrical coordination study. As-left settings and settings files must be recorded and turned over for validation.

F. Quality Process:

1. Pre-energization of electrical equipment:

a. Prior to performing pre-energization electrical testing, the GC to gather the following documentation:

1) Pre-functional testing checklists from 3PCx in accordance with 019113-General Commissioning Specification.
2) Project requirements.
3) Project basis of design.
4) Site specific drawings and documents.
5) Power system studies: Short circuit study, arc flash analysis study, protective device coordination study.
6) OEM drawings and documents.
7) OEM factory acceptance testing reports.
8) OEM Modbus/IP addressing for switchboard communication devices.
9) Protective device configuration files.*
10) IP/port list and device(s) communication addressing.
11) Automatic transfer switch configuration files.
12) Generator controls configuration files.
13) UPS configuration files.

* If site has Owner-owned MV electrical infrastructure, EOR to provide protective relay configuration files. 3PTV to coordinate with GC to obtain appropriate configuration files (3) weeks prior to onsite scope of work.

14) SEL 751 arc flash relay documents:

a) Site specific drawings and documents.
b) Power system studies: short circuit study, arc flash analysis study, protective device coordination study.
c) Switchgear/switchboard OEM drawings and documents.
d) Switchgear/switchboard OEM factory acceptance testing reports.
e) Switchgear/switchboard OEM Modbus/IP addressing for switchboard communication devices.
f) SEL 751 arc flash relay settings calculations, .rdb file and SEL 751 arc flash relay communication addressing files to be requested from the RME-EE team via bax-ee-construction-quality@(owner).com no later than (3) weeks prior to onsite scope of work.

15) Main metering (SEL 735 or PM8000) documents:

a) Site specific drawings and documents.
b) Switchgear/switchboard OEM drawings and documents.
c) Switchgear/switchboard OEM factory acceptance testing reports.
d) Switchgear/switchboard OEM Modbus/IP addressing for switchboard communication devices.
e) SEL 735 or PM8000 meter settings calculations and settings file.
f) SEL 735 or PM8000 communication addressing.

16) 3PCx to provide pre-functional testing checklists to GC.

b. GC to receive equipment shipment from OEM. Verify equipment is in accordance with owners' requirements and design documents. Identify non-conformances, log them in deficiency punch list and resolve them prior to equipment energization.
c. GC to perform pre-functional testing per 3PCx pre-functional testing checklists as outlined in 019113-General Commissioning Specification.
d. 3P-TVs to perform a site walk to field validate all project specific requirements. Prior to 3PTV mobilization to project site, 3P-TV to coordinate with GC and project teams to validate all documentation has been received and scope of work is clear. Validation to include at a minimum:

1) Verify design documentation matches site conditions.
2) Verify equipment to be inspected and tested is ready for 3PTV scope of work.
3) Verify 3PTV calibrated test equipment is available during testing.
4) For remote mounted SEL 751 arc flash relay, review site specific arc flash relay configuration and material requirements:

a) Relay and UPS systems.
b) Shunt Trips.
c) Close Coils.
d) Breaker Auxiliary Contacts.
e) Breaker Lockout Devices.
f) Fiber Optic Sensing Loops.
g) Protection Class CTs.
h) Potential Transformers.
i) Control Power Transformer.
j) Insulation barrier between main and feeder sections of switchboard.
k) Coordinate with GC to review and agree on documented LOTO plan.

5) Identify non-conformances, log them in deficiency punch list and resolve them prior to equipment energization. 3P-TV to complete a post site walk report identifying that all site walk objectives have been completed.

e. 3PTV to complete inspection and acceptance testing with GC. Refer to appendices in this document.
f. GC and 3PTV to document non-conformances in deficiency punch list. Resolve punch list items prior to equipment energization.
g. GC to provide and coordinate permits, AHJ inspections, utility work, switching procedures and LOTO procedures prior to first time energization of electrical equipment.

2. First time energization of electrical equipment:

a. GC to perform LOTO procedures and first-time energization switching procedures.
b. 3PTV to perform energized electrical acceptance testing of electrical equipment as required. GC to support 3PTV.
c. GC to coordinate energized metering testing with 3PTV.
d. GC and 3PTV to document non-conformances in deficiency punch list. Resolve punch list items prior to equipment being placed into service.
e. 3PCx to perform functional testing per 3PCx functional testing checklists as outlined in 019113-General Commissioning Specification.

3. Pre-launch open, clean and inspection:

a. Pre-launch open, clean and inspection to be completed within 90 days prior to launch of the building. De-energization or shutdown of electrical equipment to be coordinated with the construction manager.
b. Prior to performing open, clean and inspection, the following documentation to be provided to Owner by the GC and 3PTV:

1) Completed electrical deficiencies/punch-list reports.
2) Completed electrical acceptance testing reports.
3) Completed pre-functional testing checklists.
4) Completed SEL 751 arc flash relay installation, configuration, and startup report.
5) Completed electrical metering installation, configuration, and startup report.

c. Prior to building launch, main distribution equipment to be de-energized to perform a final inspection. This inspection is intended to perform functionality verification for critical electrical equipment, ensure cleanliness, and serve as a final, documented inspection of the equipment to ensure no major defects exist prior to building handover to operations. GC to coordinate outages.
d. Prior to de-energization of electrical equipment, perform the following:

1) Switchboards & switchgear:

a) Validate main metering readings. Capture screenshots and waveforms.
b) Validate circuit breaker integrated metering. Capture screenshots and waveforms.
c) Validate protective relay metering readings. Capture screenshots and waveforms.
d) Validate BMS connectivity and communication for electrical metering. Validate readings, capture screenshots and waveforms.

e) Validate BMS connectivity and communication for protective relays. Validate readings, capture screenshots and waveforms.
f) Validate BMS connectivity and communication for SEL 751 arc flash relay. Validate readings, capture screenshots and waveforms.
g) Validate settings and configuration files for SEL 751 arc flash relay, main metering, integrated metering, protective relays are in accordance with design documentation and protective device coordination study. Capture as built settings and configuration files.
h) Validate arc flash labels are per arc flash analysis study.

e. After de-energization of electrical equipment, GC and 3PTV to perform the following:

1) Switchboards & switchgear:

a) Verify UPS is ON and supplying voltage. Validate switching functionality from local controls.
b) Verify UPS is ON and supplying voltage. Validate switching functionality from remote controls.
c) Open equipment, clean, perform visual inspection.
d) Document as-found condition photos.
e) Document as-left condition photos.

2) Automatic transfer switches & backup generation:

a) Validate startup of emergency generator and transfer of ATSs when switchboard line side power is removed.
b) Validate transfer of ATS when normal power is restored and verify that generator shuts down after specified cool down period.
c) Record as-left ATS set points and validate against design documentation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. 3PTV to provide all required testing instruments and equipment with calibration certificates. Calibration certificates to be up to date in accordance with test instrument/equipment requirements.

B. 3PTV to provide all software and licenses required to perform testing on electrical equipment.

C. GC and 3PTV to provide materials required to resolve issues that are observed during inspection and testing of electrical equipment.

D. GC and 3PTV to provide all necessary personal protective equipment (PPE) to execute inspection and testing.

E. GC and 3PTV to provide all tools to execute inspection and testing.

F. GC and 3PTV to provide all machinery such as scissors lifts and forklifts, as required, to perform the required scope of work as outlined in this document.

G. GC and 3PTV to work with CM to coordinate mobilization requirements such as site access, site vehicle parking, site machinery parking, equipment laydown areas, etc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine site and equipment conditions prior to performing work. Notify construction manager if unsatisfactory conditions are present. Do not begin any activities if site conditions are unsatisfactory.

3.2 ACCEPTANCE TESTING

A. The following equipment to be tested by the 3PTV in accordance with this document:

1. Switchboard, Low Voltage:

   a. Quantity to test: 100%.
   b. Follow Appendix A and NETA ATS.

2. Switchboard, SEL 751 Relay:

   a. Quantity to test: 100%.
   b. Follow Appendix C and NETA ATS.

3. Remote mount SEL 751 arc flash relay [Applicable to retrofits. Implementation for BTS sites to be approved by Tenant]:

   a. Quantity to test: 100%.
   b. Follow Appendix D and NETA ATS.

4. Switchboard main meter (SEL 735 and PM8000):

   a. Quantity to test: 100%.
   b. Follow Appendix E and NETA ATS.

5. Switchboard integrated metering and sub-metering:

   a. Quantity to test: 100%.
   b. Follow Appendix F, H and NETA ATS.

6. Switchgear, Low Voltage. This includes Current transformers, potential transformers, protective relays, main metering and sub-metering, communication devices, circuit breakers, surge protection devices, UPS, and electronic trip units.

   a. Quantity to test: 100%.
   b. Follow Appendix A and NETA ATS.

7. Switchgear, Medium Voltage. This includes Current transformers, potential transformers, protective relays, main metering and sub-metering, communication devices, circuit breakers, surge protection devices, UPS, and electronic trip units.

a. Quantity to test: 100%.
b. Follow Appendix B and NETA ATS.

8. Panelboards, greater than or equal to 800A:

a. Quantity to test: 100%.
b. Follow NETA ATS.

9. Distribution panels, greater than or equal to 800A:

a. Quantity to test: 100%.
b. Follow NETA ATS.

10. Motor Control Center (MCC):

a. Quantity to test: 100%.
b. Follow Appendix K and NETA ATS.

11. Metal enclosed busways and plug ins:

a. Quantity to test: 100%.
b. Follow NETA ATS.

12. Transformers, dry type, low voltage, small:

a. Quantity to test: 20%.
b. Follow NETA ATS.

13. Transformers, dry type, low voltage, large:

a. Quantity to test: 100%. [If owned by utility, acceptance testing not required.]
b. Follow NETA ATS.

14. Transformers, liquid filled:

a. Quantity to test: 100%. [If owned by utility, acceptance testing not required.]
b. Follow Appendix G and NETA ATS.

15. Transformers, tap changers:

a. Follow percentages above for dry type and liquid filled transformers.
b. Follow NETA ATS.

16. Generators:

a. Quantity to test: Testing by generator manufacturer field service personnel.

17. Generator connection cabinet:

a. Quantity to test: 100%.
b. Follow NETA ATS.

18. Generator EGEN and SGEN panels:

a. Quantity to test: 100%.

b. Follow NETA ATS.

19. Cables, low voltage, 600V max.:

a. Scope performed by general contractor for each cable.
b. Follow NETA ATS.

20. Cables, medium and high voltage:

a. Quantity to test: 100%.
b. Follow NETA ATS.

21. Switches, Air, Medium-Voltage, Metal-Enclosed:

a. Quantity to test: 100%.
b. Follow NETA ATS.

22. Switches, Vacuum, Medium-Voltage:

a. Quantity to test: 100%.
b. Follow NETA ATS.

23. Switches, SF6, Medium-Voltage:

a. Quantity to test: 100%.
b. Follow NETA ATS.

24. Disconnects, Fusible Panelboard Switches:

a. Quantity to test: 100%.
b. Follow NETA ATS.

25. Circuit Breakers, Air, Insulated-Case/Molded-Case (MCCB):

a. Quantity to test: 100%.
b. Follow NETA ATS.

26. Circuit Breakers, Air, Medium-Voltage:

a. Quantity to test: 100%.
b. Follow NETA ATS.

27. Circuit Breakers, Vacuum, Medium-Voltage:

a. Quantity to test: 100%.
b. Follow NETA ATS.

28. Circuit Breakers, SF6:

a. Quantity to test: 100%.
b. Follow NETA ATS.

29. Circuit Breakers, Electronic Trip Units:

a. Quantity to test: 100%.

b. Follow NETA ATS.

30. Protective Relays, Microprocessor-Based:

a. Quantity to test: 100%.
b. Follow NETA ATS.

31. Instrument transformers (CTs and PTs):

a. Quantity to test: In accordance to respective equipment percentages as outlined in this document.
b. Follow NETA ATS.

32. Metering Devices, Microprocessor-Based:

a. Quantity to test: 100%.
b. Follow Appendix H and NETA ATS.

33. Grounding systems:

a. Quantity to test: 100%.
b. Follow Appendix J and NETA ATS.

34. Surge Arresters, Medium- and High-Voltage:

a. Quantity to test: 100%.
b. Follow NETA ATS.

35. Automatic Transfer Switches:

a. Quantity to test: 100%.
b. Follow Appendix I and NETA ATS.

36. Uninterruptible Power Supply (UPS):

a. Quantity to test: 100%.
b. Follow NETA ATS.

B. 3PTV to track non-conformances in deficiency punch list, resolve identified deficiencies and retest prior to equipment startup and energization.

C. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

D. The checklists in the appendices are based on NETA Acceptance Testing Specification (ATS).

E. If an electrical equipment requires inspection and acceptance testing and is not listed in this document then utilize NETA ATS as reference to perform inspection and acceptance testing.

3.3 END OF SECTION

REVISION CONTROL

Revision	Author(s)	Status	Comments
0.0	@bryanvmi @schulthl @rishpte @cunnyngb @leoarred @brfranka	Issued	Initial release.

APPENDICES

Appendix	Description
A	SWITCHGEAR/SWITCHBOARD, LOW VOLTAGE
B	SWITCHGEAR, MEDIUM VOLTAGE
C	SWITCHBOARD, SEL 751 ARC FLASH RELAY
D	REMOTE MOUNT, SEL 751 ARC FLASH RELAY
E	SWITCHBOARD, SEL 735 & PM8000 MAIN METERING
F	SWITCHBOARD, CIRCUIT BREAKER INTEGRATED METERING
G	TRANSFORMER, OIL FILLED, ACCEPTANCE TESTING
H	METERING DEVICE, ACCEPTANCE TESTING
I	AUTOMATIC TRANSFER SWITCH, ACCEPTANCE TESTING
J	GROUNDING SYSTEM, ACCEPTANCE TESTING
K	MOTOR CONTROL CENTER (MCC), ACCEPTANCE TESTING

APPENDIX A: SWITCHGEAR/SWITCHBOARD, LOW VOLTAGE, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING SWITCHGEAR/SWITCHBOARD, LOW VOLTAGE			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

Complete		Task	Comments
VISUAL AND MECHANICAL INSPECTION			
□Yes	□No	Compare equipment nameplate data with drawings and specifications.	
□Yes	□No	Take picture of nameplate and add to testing report.	
□Yes	□No	Inspect physical, electrical, and mechanical condition.	
□Yes	□No	Inspect anchorage, alignment, grounding, and required area clearances	
□Yes	□No	Clean unit.	
□Yes	□No	Verify all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.	
□Yes	□No	Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker address for microprocessor-communication packages.	
□Yes	□No	Verify that current and voltage transformer ratios correspond to drawings and power system coordination study.	
□Yes	□No	Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.	
□Yes	□No	Verify all interconnect wiring is connected and any other equipment provided by OEM has been installed in the field (Such as neutral CT connections and temperature detectors).	
□Yes	□No	Verify all bolted electrical connections have been torqued and marked.	
□Yes	□No	Confirm correct operation and sequencing of electrical and mechanical interlock systems. • Attempt closure on locked-open devices. Attempt to open locked-closed devices. • Make key exchange with all devices included in the interlock scheme.	
□Yes	□No	Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.	
□Yes	□No	Inspect insulators for evidence of physical damage or contaminated surfaces.	
□Yes	□No	Verify correct barrier and shutter installation and operation.	
□Yes	□No	Exercise all active components.	
□Yes	□No	Inspect mechanical indicating devices for correct operation.	
□Yes	□No	Verify that filters are in place and vents are clear.	
□Yes	□No	Perform visual and mechanical inspection of instrument transformers in accordance with this document.	
□Yes	□No	Perform visual and mechanical inspection of surge arresters in accordance with this document.	
□Yes	□No	Perform visual and mechanical inspection of microprocessor relays in accordance with this document.	

□Yes □No	Perform visual and mechanical inspection of control power transformers in accordance with this document.	
□Yes □No	Use wiring schematic to perform a functional checkout on control wiring. • Use printed out drawings, laptop, or I-pad to highlight wiring schematic once it has been verified.	
□Yes □No	Verify all correct labeling is installed (AF, LOTO Placards, Etc.).	
ACCEPTANCE TESTING		
□Yes □No	Perform contact resistance testing on bolted electrical connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. Complete all horizontal and vertical sections.	
□Yes □No	Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground. Apply voltage in accordance with manufacturer's published data.	
□Yes □No	Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data.	
□Yes □No	Perform electrical tests on instrument transformers in accordance with procedure outlined in this document.	
□Yes □No	Perform ground-resistance tests in accordance with procedure outlined in this document.	
□Yes □No	Test metering devices in accordance with procedure outlined in this document.	
□Yes □No	Test control Power Transformers in accordance with procedure outlined in this document.	
□Yes □No	Test voltage Transformers in accordance with procedure outlined in this document.	
□Yes □No	Test microprocessor relays in accordance with procedure outlined in this document.	
□Yes □No	Verify operation of cubicle switchgear/switchboard space heaters and their controller.	
□Yes □No	Perform electrical tests of surge arresters in accordance with procedure outlined in this document.	

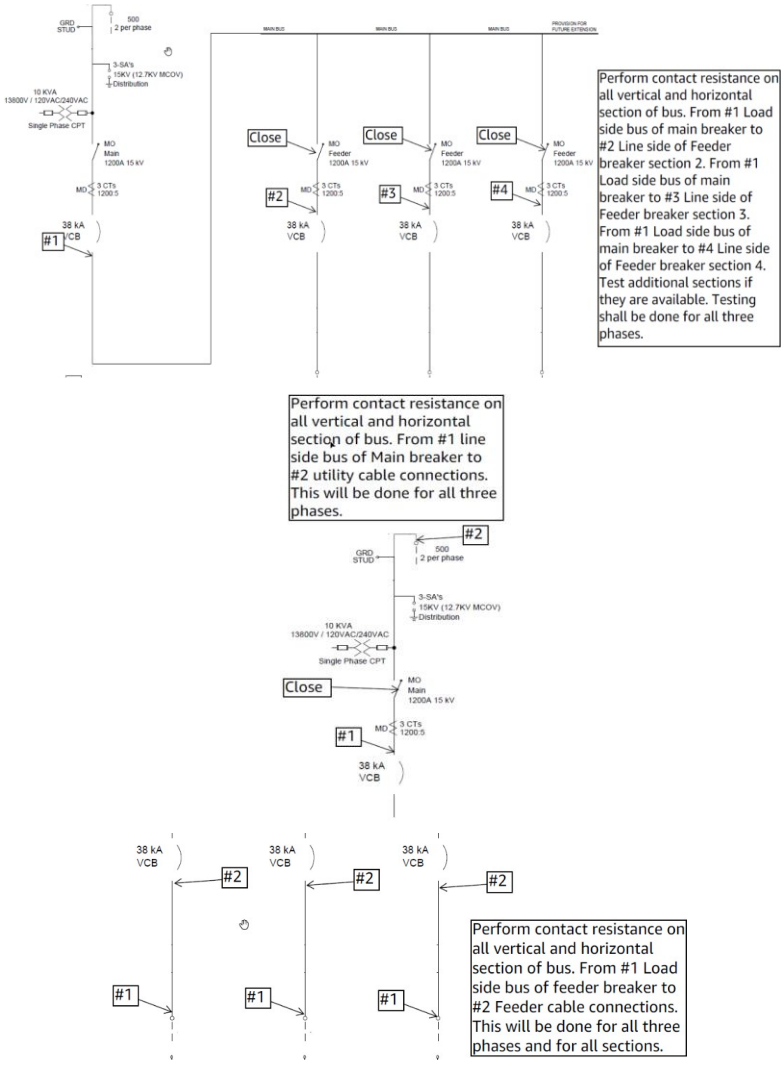
APPENDIX B: SWITCHGEAR, MEDIUM VOLTAGE, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING SWITCHGEAR, MEDIUM VOLTAGE			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

Complete	Task	Comments
VISUAL AND MECHANICAL INSPECTION		
□Yes □No	Compare equipment nameplate data with drawings and specifications.	
□Yes □No	Take picture of nameplate and add to testing report.	
□Yes □No	Inspect physical, electrical, and mechanical condition.	
□Yes □No	Inspect anchorage, alignment, grounding, and required area clearances.	
□Yes □No	Clean unit	
□Yes □No	Verify all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.	
□Yes □No	Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker address for microprocessor-communication packages.	
□Yes □No	Verify that current and voltage transformer ratios correspond to drawings and power system coordination study.	
□Yes □No	Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.	
□Yes □No	Verify minimum bend radius is maintained.	
□Yes □No	Verify all bolted electrical connections have been torqued and marked.	
□Yes □No	Confirm correct operation and sequencing of electrical and mechanical interlock system. • Attempt closure on locked-open devices. Attempt to open locked-closed devices. • Make key exchange with all devices included in the interlock scheme.	
□Yes □No	Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.	
□Yes □No	Inspect insulators for evidence of physical damage or contaminated surfaces.	
□Yes □No	Verify correct barrier and shutter installation and operation.	
□Yes □No	Exercise all active components.	
□Yes □No	Inspect mechanical indicating devices for correct operation.	
□Yes □No	Verify that filters are in place and vents are clear.	
□Yes □No	Perform visual and mechanical inspection of instrument transformers in accordance with procedure outlined in this document.	
□Yes □No	Perform visual and mechanical inspection of surge arresters in accordance with procedure outlined in this document.	
□Yes □No	Inspect control power transformers in accordance with procedure outlined in this document.	
□Yes □No	Perform visual and mechanical inspection of microprocessor relays in accordance with procedure outlined in this document.	
□Yes □No	Use wiring schematic to perform a functional checkout on control wiring.	

	• Use printed out drawings, laptop, or I-pad to highlight wiring schematic once it has been verified	
□Yes □No	Verify all necessary labels are present (AF, LOTO, etc.)	
ACCEPTANCE TESTING		
□Yes □No	Perform contact resistance testing on bolted electrical connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. Complete all horizontal and vertical sections. 	
□Yes □No	Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground. Apply voltage in accordance with manufacturer's published data.	
□Yes □No	Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data.	
□Yes □No	Perform electrical tests on current transformers in accordance with procedure outlined in this document.	

□Yes □No	Perform ground-resistance tests in accordance with procedure outlined in this document.	
□Yes □No	Test metering devices in accordance with procedure outlined in this document.	
□Yes □No	Test control power transformers in accordance with procedure outlined in this document.	
□Yes □No	Test voltage transformers tests in accordance with procedure outlined in this document.	
□Yes □No	Test microprocessor relays in accordance with procedure outlined in this document.	
□Yes □No	Verify operation of cubicle switchgear/switchboard space heaters and their controller.	
□Yes □No	Perform electrical tests of surge arresters in accordance with procedure outlined in this document.	

APPENDIX C: SWITCHBOARD, SEL 751 ARC FLASH RELAY, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING SWITCHBOARD, SEL 751 ARC FLASH RELAY			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Communication settings for SEL 751 to be set by the 3PTV in collaboration with the on-site IT team. This includes (as applicable): IP addressing, subnet mask, MODBUS register mapping, port settings, baud rate, data speed, data bits, stop, bits, parity, and other relevant communication settings.
2. The on-site third-party testing vendors are responsible for uploading device settings to the relay.
3. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

VISUAL AND MECHANICAL INSPECTION [PRE-ENERGIZATION]			
Complete		**Task**	**Comments**
RECORD KEEPING AND DOCUMENTATION			
□Yes	□No	Take pictures of relay front, back, nameplate and model information.	
□Yes	□No	Take pictures of relay test switch front and back.	
□Yes	□No	Take pictures of each section main switchboard section, internal and external, and manufacturers job number.	
□Yes	□No	Record relay model number, style number, serial number, firmware version, software version and control voltage.	
□Yes	□No	Verify OEM has performed internal factory acceptance testing and quality assurance checks and obtain those reports.	
□Yes	□No	Verify approved as-manufactured drawings are present during testing.	
□Yes	□No	Verify equipment datasheets and manuals are present during testing.	
□Yes	□No	Verify communication mapping documentation is present during testing.	
□Yes	□No	Utilize application guide “AG2011-01, Using SEL Relays for Arc-Flash Detection, Mark Zeller, Ariana Hargrave, and Derrick Haas” for routing of fiber cables and testing of relay.	
□Yes	□No	Verify that testing personnel have the following test equipment: • Secondary injection test set • Multimeter • Arc flash relay testing kit (SEL-4520 or equivalent) • Test cables and accessories • Test switch test paddles, cables and accessories	
□Yes	□No	Receive approval from Owner of a written lockout-tagout (LOTO) plan that includes switching procedures. Must have a call with Owner electrical engineer prior to starting work.	
MECHANICAL INSPECTION			
□Yes	□No	Verify there is no mechanical damage to relay.	
□Yes	□No	Verify there is no liquid damage to relay.	
□Yes	□No	Verify relay frame is grounded in accordance with manufacturer’s instructions.	
□Yes	□No	Verify communications cables are connected to relay as shown in the drawings.	
□Yes	□No	Verify fuse blocks and fuse ratings are as rated in the drawings.	
□Yes	□No	Perform point to point check on relay wiring and relay test switch wiring. [Any issues with wiring to be identified via red-lines]	
□Yes	□No	Verify ferrules and lugs are rated and sized correctly per wire gauge.	
□Yes	□No	Verify wiring bundles do not exceed NFPA 70 requirements.	
□Yes	□No	Verify test switch part number is in accordance with design documentation.	

□Yes □No	Inspect wiring for pinch points and damage.	
□Yes □No	Perform a pull test on the wiring to ensure that screws, nuts and bolts are tightened and torqued.	
LISTING AND LABELING		
□Yes □No	Verify phenolic or equivalent labeling is present on relay and associated equipment and that labeling matches drawings.	
□Yes □No	Verify that all wires are labeled with TO and FROM information.	
□Yes □No	Verify relay labels match pushbutton and light-emitting diode functionality.	
□Yes □No	Verify relay labels match LED and PB function. Owner will not accept any handwritten tags.	
CURRENT TRANSFORMER CHECKLIST		
□Yes □No	Verify CT circuit is grounded at only one point.	
□Yes □No	Record current transformer master ratio and tapped ratio.	
□Yes □No	Verify CT ratings and type match with design documentation.	
□Yes □No	Verify CT is relaying type.	
POTENTIAL TRANSFORMER CHECKLIST		
□Yes □No	Verify PT circuit is grounded at only one point.	
□Yes □No	Verify potential transformer ratings and type match with design documentation.	
□Yes □No	Record relay voltage transformer configuration (Open delta, 3W-wye, 4W-wye, etc.).	
RELAY INSPECTION AND TESTING		
□Yes □No	Verify lockout-tagout and switching procedures have been performed prior to testing.	
□Yes □No	Connect temporary control power for the purposes of testing (As required).	
□Yes □No	Connect all interconnect wiring for the purposes of testing.	
□Yes □No	Route all fiber optic cables and connect to the relay.	
□Yes □No	Record incoming service voltage.	
□Yes □No	Record phase rotation and phasing order. Verify the relay is set correctly based on phase rotation and phasing order.	
□Yes □No	Record IP address, subnet mask, gateway, BACnet protocol.	
□Yes □No	Set the relay in accordance with the engineered settings file.	
□Yes □No	Record passwords for all relay access levels.	
□Yes □No	Record all relevant communications settings and data mapping and ensure settings and data mapping are per design requirements.	
□Yes □No	In the terminal window perform STA and FID and screenshot for final report.	
□Yes □No	Set time and date on relay (Ensure relay is set to the correct time zone).	
□Yes □No	Verify UPS Alarm is working by jumper the contact on the back of the UPS. The LED on front of the relay illuminates and stack light alarms.	

□Yes □No	Open the control power fuse and verify Control Power LED on front of relay illuminates and stack light alarms.	
□Yes □No	Verify all CT and PT interconnect wiring has been landed. Verify shorting terminal block screws are not engaged (CT not shorted). Verify current transformers are not shorted.	
□Yes □No	Unplug 1 fiber loop and run AFT in command prompt or front screen. Verify Relay Alarm LED on front of relay illuminates and stack light alarms. (Screenshot AFT command in terminal window). Re-plug the fiber loop.	
□Yes □No	Perform function testing on main breaker (Start with all test switches closed): -Press PB03 for 3 seconds until 2 amber lights flash (30 sec delay). Breaker should close. -Open OUT301 test switch. -Press PB04 for 3 seconds until 2 amber lights flash (30 sec delay). Breaker should not trip. -Close OUT301 test switch. -Press PB04 for 3 seconds until 2 amber lights flash (30 sec delay). Breaker should trip	
□Yes □No	Perform function testing on solar breaker (Start with all test switches closed) -Press PB01 for 3 seconds until 2 amber lights flash (30 sec delay). Breaker should close. -Open OUT302 test switch. -Press PB02 for 3 seconds until 2 amber lights flash (30 sec delay). Breaker should not trip. -Close OUT302 test switch. -Press PB02 for 3 seconds until 2 amber lights flash (30 sec delay). Breaker should trip.	
□Yes □No	Close all current test switches. Apply primary current to A Phase CT while establishing voltage reference to verify polarity.	
□Yes □No	Perform secondary current injection testing. Record relay values. -Verify relay reads correct current measurements. Open A-phase current test switch. A-phase Current should measure 0A when the polarity test switch for that phase is open. Close A-phase current test switch. Verify current is seen on relay. Record snapshot of phasor diagrams. -Verify relay reads correct current measurement. Open B-phase current test switch. B-phase Current should measure 0A when the polarity test switch for that phase is open. Close B-phase current test switch. Verify current is seen on	

	relay. Record snapshot of phasor diagrams. -Verify relay reads correct current measurement. Open C-phase current test switch. C-phase Current should measure 0A when the polarity test switch for that phase is open. Close C-phase current test switch. Verify current is seen on relay. Record snapshot of phasor diagrams. Record test set current values: A Phase: B Phase: C Phase: Neutral (If Applicable): Record SEL-751 relay current value on the front screen: A Phase: B Phase: C Phase: Neutral (If Applicable):	
□Yes □No	Verify AF trip with current and light -Open OUT301, OUT302, OUT303 test switches. -Secondary inject relay to pick-up 50PAFP -Utilize SEL-4520 arc flash test module or equivalent to flash fiber until TOL picks up and verify relay wordbit asserts on AF, but no breakers operate. [Test each fiber and record results] -Close OUT301, OUT302, OUT303 test switches. -Secondary inject relay to pick-up 50PAFP -Utilize SEL-4520 arc flash test module or equivalent to flash fiber until TOL picks up and verify main and solar circuit breakers operate. [Test each fiber and record results] -Close test all test switches	
□Yes □No	Run TOL command and screenshot.	
□Yes □No	Run AFT command and screenshot.	
□Yes □No	Run SER command and screenshot.	
□Yes □No	Clear the SER & HIS in terminal window.	
□Yes □No	Retrieve “As Left” settings from relay. Upload .rdb files with report	
□Yes □No	Perform a compare of “As Left” settings to template file, making sure only differences are what are expected.	
□Yes □No	Take after pictures of inside of switchboard, relay front and back, test switches front and back.	
□Yes □No	Apply updated AF label on Main and Feed sections. Should be one label per section. Remove all old labels.	
□Yes □No	Take pictures of arc flash labels for the final report.	
□Yes □No	Final inspection: -Check all wiring connections are correct and terminations and screws are tight. -Check polarity of all CT wiring -Check all fuses are installed and of proper rating.	

	-Verify Ground and LOTO have been removed. -Verify test switches are closed and covers are placed on test switches. -Perform final insulation resistance testing before installing covers. Record values.	
COMMUNICATION INSPECTION AND TESTING		
□Yes □No	Verify CAT6 is connected to Port 1 on the back of the relay.	
□Yes □No	Record communication settings: MAC address, IP address, subnet mask, gateway, BACnet protocol, firmware version, etc.	
□Yes □No	Record communication cable termination location and port number.	
□Yes □No	Coordinate with GC and building management system team(s) to verify that the building management system is retrieving all required data and data is calibrated and reading correctly.	
FINAL INSPECTION		
□Yes □No	Take pictures of each switchboard section (front compartments, back compartments and communications compartments).	
□Yes □No	Take pictures of current transformer shorting blocks.	
□Yes □No	Take pictures of test switches.	
□Yes □No	Verify grounds and LOTO have been removed.	
□Yes □No	Verify cleanup and housekeeping is complete.	
□Yes □No	Prior to full operation, the general contractor, in the presence of the relay commissioning agent, to perform a complete demonstration and testing of the relay operation functions, alarms, and communications. Upon successful completion of system operation, the contractor to submit a statement in writing stating that the full operation of all systems, functions, alarms and communications have been demonstrated and are operational as well as a listing of all systems, alarms, functions that have been commissioned.	
STARTUP AND ENERGIZED CHECKLIST		
□Yes □No	Verify with all parties that the building is ready to be re-energized.	
□Yes □No	Verify utility is prepared to re-energize the site (if applicable).	
□Yes □No	Verify that all switching orders have been completed prior to operation of switchboard circuit breakers.	
□Yes □No	Verify line side of Main Breaker is energized by verifying line side voltage on the SEL751 relay.	
□Yes □No	Initiate a close command from the SEL 751. Main Breaker to close after 30 sec delay.	
□Yes □No	Check three-phase voltage is correct for the system voltage compared to pre-outage numbers.	
□Yes □No	Check currents compared to other power meters on switchboard and pre-outage numbers.	
	Verify relay communications are operational and recording correct data. Record results.	

□Yes □No	Check no negative sequence voltage (3V2), take photo to submit with job report – if negative sequence voltage present verify phasing on relay.	
□Yes □No	Take photo of voltage and current readings on the relay, to submit with the job report.	
□Yes □No	Verify there are no alarms on the relay.	
□Yes □No	Ensure the UPS transferred to utility power.	
□Yes □No	If site has ATS ensure transfer back to primary source.	

APPENDIX D: REMOTE MOUNT, SEL 751 ARC FLASH RELAY, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING REMOTE MOUNT, SEL 751 ARC FLASH RELAY			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Communication settings for SEL 751 to be set by the 3PTV in collaboration with the on-site IT team. This includes (as applicable): IP addressing, subnet mask, MODBUS register mapping, port settings, baud rate, data speed, data bits, stop, bits, parity, and other relevant communication settings.
2. The 3PTV are responsible for uploading device settings to the relay.
3. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

VISUAL AND MECHANICAL INSPECTION [PRE-ENERGIZATION]		
Complete	**Task**	**Comments**
PRE-OUTAGE		
□Yes □No	Review scope of work document for relay install.	
□Yes □No	Review site specific arc flash relay configuration and material requirements.	
□Yes □No	Complete wiring between UPS and Relay cabinet (Pre-Work).	
□Yes □No	Complete BMS scope of work for relay system per design documentation.	
□Yes □No	Validate conduits between relay and IDF cabinets or BMS cabinets have been installed and cables routed (Pre-Work).	
□Yes □No	Take before pictures of the exterior of main switchboard including main switchboard nameplate with manufacturer job number.	
□Yes □No	Document system voltage utilizing existing metering at each main switchboard for all three phases.	
□Yes □No	Record amperage at main circuit breaker or bolted pressure switch for all three phases and neutral.	
□Yes □No	A written document must include the positions of the breaker: Take Pictures ON or OFF position.	
□Yes □No	Take pictures of relay enclosure number, relay SN, UPS SN for report.	
ARC FLASH RELAY AND UPS INSTALLATION		
□Yes □No	Perform LOTO per LOTO plan agreed on during pre-outage calls.	
□Yes □No	Take before pictures of inside switchboard (each section).	
□Yes □No	Demo any existing equipment agreed upon during scope review call (Undervoltage (UV) relays or relays that trip the main breaker). No DEMO scope on solar circuit breaker. Do not remove switchboard metering.	
□Yes □No	Apply cover plates to relay openings after demo (if applicable).	
□Yes □No	If the site has fire department emergency switch route to SEL IN302.	
□Yes □No	Terminate all wiring per wiring diagrams – SEL Relay, terminal blocks, CTs.	
□Yes □No	Verify CT Ratio per CTs and relay settings: SEL 751 CT ratio: _____	
□Yes □No	Route fiber loops and complete fiber installation per SEL guideline AG2011-01.	
□Yes □No	Install breaker accessories as needed on Main and Solar breaker. Shunt Trip, Close Coil, 52 Contact (120VAC).	
□Yes □No	If the site has a Generator that backs up the Main breaker wire the generator start signal from ATS in series with the SEL OUT303 (identified during site walk).	
□Yes □No	Verify fuse block is installed in low voltage compartment for voltage tap going to relay system.	
□Yes □No	Ensure breaker push button LOTO devices are installed.	

□Yes □No	Perform wire check per wiring diagram and take picture of CT wiring.	
□Yes □No	Energize UPS to power relay.	
□Yes □No	Establish communication with relay.	
□Yes □No	Update relay TID and RID: TID = Owner Site Code RID = MSB, MSA	
□Yes □No	Set time and date on relay (ensure relay is set to correct time zone).	
□Yes □No	In the terminal window perform STA screenshot each for final report.	
□Yes □No	Hold momentary jumper across the UPS alarm contact in UPS enclosure and verify UPS Alarm LED on front of the relay illuminates and stack light alarms.	
□Yes □No	Open control power and verify Control Power LED on front of relay illuminates and stack light alarms.	
□Yes □No	Re-install control power fuse and verify Control Power LED clears.	
□Yes □No	If Fire Emergency switch exists ☐ Open trip test switch that controls Main and Solar breaker trip ☐ Activate fire alarm emergency switch ☐ Verify all breakers wired to relay do not operate. ☐ Close test switches and verify all applicable breakers operate. ☐ Disengage fire emergency switch	
□Yes □No	Unplug 1 fiber loop and run AFT in command prompt or front screen. Verify Relay Alarm LED on front of relay illuminates and stack light alarms.	
□Yes □No	Re-plug the fiber loop	
□Yes □No	Perform AFT test in command prompt, this will reset relay alarm LED.	
□Yes □No	Take a screenshot of AFT failure and pass for Job report. Desire light level of 90% or greater.	
□Yes □No	Verify relay labels match LED and PB function per the settings file. NO handwritten tags.	
□Yes □No	Perform function testing on main breaker (Start with all test switches closed) ☐ Press PB03 for 3 seconds until 2 amber lights flash (30 sec delay) ☐ Breaker should close ☐ Open test switch main breaker trip ☐ Press PB04 for 3 seconds until 2 amber lights flash (30 sec delay) ☐ Breaker should NOT trip ☐ Close test switch for main breaker trip ☐ Press PB04 for 3 seconds until 2 amber lights flash (30 sec delay) ☐ Breaker should trip	
□Yes □No	Perform function testing on solar breaker (Start with all test switches closed)	

	☐ Press PB01 for 3 seconds until 2 amber lights flash (30 sec delay) ☐ Breaker should close ☐ Open test switch for solar trip ☐ Press PB02 for 3 seconds until 2 amber lights flash (30 sec delay) ☐ Breaker should NOT trip ☐ Close test switch for solar trip ☐ Press PB02 for 3 seconds until 2 amber lights flash (30 sec delay) ☐ Breaker should trip	
□Yes □No	Close all current test switches. Apply primary current to A Phase CT while establishing voltage reference to verify polarity. Important Note: When current is being applied, values from the test set and relay should read the same value, be sure to inject a minimum of 100 amps. When applying current on an individual CT as listed below, no other current element should read current. Depending on the test setup, calculate/apply primary current by wrapping CT's. Current will be within the accuracy of the test setup +/- 10%	
□Yes □No	With test switch closed, ensure relay reads appropriate current on phase being injected and correct polarity. Individually open each A Phase test switch. Current should ONLY GO AWAY when the polarity test switch for that phase is open. Ensure current goes away. Ensure current remains when return test switch for that phase is open	
□Yes □No	Close all current test switches. Apply primary current to B Phase CT as described above. Individually open each B Phase test switch and verify as above.	
□Yes □No	Close all current test switches. Apply primary current to C Phase CT as described above. Individually open each C Phase test switch and verify as above.	
□Yes □No	Test set current "if wrapping CTs write calculated current" A Phase: B Phase: C Phase: Neutral (If Applicable): SEL-751 relay current value on the front screen A Phase: B Phase: C Phase: Neutral (If Applicable):	
□Yes □No	Verify AF trip with current and light ☐ Open "trip" test switches ☐ Secondary inject relay with enough current to pick-up 50PAFP. Verify input card is rated for testing current	

	☐ For each fiber Flash with camera, laser or bright light until TOL picks up and verify relay trips on AF, but no breakers operate. ☐ Close “trip” test switches ☐ Secondary inject relay to pick-up 50PAFP. Verify input card is rated for testing current ☐ For each fiber Flash with camera, laser or bright light until TOL picks up and verify relay trips, main breaker and solar breaker ☐ Close test switches	
□Yes □No	Clear the SER & HIS on the SEL.	
□Yes □No	Ensure CAT6 is connected to Port 1 on back of relay. This is for the BMS connection.	
□Yes □No	Retrieve “As Left” settings from relay. Upload .rdb files with report.	
□Yes □No	Perform a compare of “As Left” settings to template file making sure only differences are what is expected.	
□Yes □No	Take after pictures of inside of switchboard.	
□Yes □No	Affix the SEL 751 Arc Flash Relay SOP to the relay enclosure. Contact RME GEE for SOP.	
□Yes □No	Apply updated arc flash label on Main and feeder sections. Should be one label per sections. Remove all old labels. Label templates to be provided by arc flash vendor. 3PTV to print and apply label.	
□Yes □No	Take pictures of arc flash labels for the closeout report.	
□Yes □No	Final inspection by vendor. ☐ Check all wiring connections are correct, and terminations / screws are tight. ☐ Check polarity of all CT wiring ☐ Check all fuses are installed and of proper rating. ☐ Perform final megger directly before installing covers. If connected to XFMR perform over all phase to ground test	
ENERGIZATION		
□Yes □No	Verify Grounds and LOTO has been removed.	
□Yes □No	Verify with all parties that the building is ready to be re-energized.	
□Yes □No	Have utility re-energize the site (if applicable).	
□Yes □No	Verify correct line side voltage on Medium Voltage or 480V equipment metering.	
□Yes □No	Close site owned MV equipment (if applicable).	
□Yes □No	Close MSB Main breaker using the Arc Flash Relay.	
□Yes □No	Verify Main breaker has closed.	
□Yes □No	Check three-phase voltage is correct for the system voltage compared to pre-outage numbers.	
□Yes □No	Check currents compared to other power meters on switchboard and pre-outage numbers.	
□Yes □No	Check no negative sequence voltage [3V2], take photo to submit with job report – if negative sequence voltage present verify phasing on relay.	

□Yes □No	Take photo of voltage and current readings and verify on relay, to submit with the job report.	
□Yes □No	Ensure no alarms on the SEL relay.	
□Yes □No	Ensure the UPS transferred to utility power, front toggle switch is on and dark solid line inside circle on front of UPS display goes from input to load as shown below. 	
□Yes □No	If site has ATS ensure transfer back to primary source.	
□Yes □No	Take exterior photos of main switchboard.	
REPORTING		
□Yes □No	Insert all photos as specified in checklist above.	
□Yes □No	Submit completed report and as left .rdb files.	

APPENDIX E: SWITCHBOARD, SEL 735 & PM8000 MAIN METERING, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING SWITCHBOARD, SEL 735 & PM8000 MAIN METERING			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Communication settings for SEL 735, PM8000 to be set by the on-site third-party testing vendors in collaboration with the on-site IT team. This includes (as applicable): IP addressing, subnet mask, MODBUS register mapping, port settings, baud rate, data speed, data bits, stop, bits, parity, and other relevant communication settings.
2. The on-site third-party testing vendors are responsible for uploading device settings to the meter.
3. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

VISUAL AND MECHANICAL INSPECTION [PRE-ENERGIZATION]			
Complete		**Task**	**Comments**
RECORD KEEPING AND DOCUMENTATION			
□Yes	□No	Take pictures of meter front, back, nameplate and model information.	
□Yes	□No	Take pictures of meter test switch front and back.	
□Yes	□No	Record meter model number, style number, serial number, firmware version, software version and control voltage.	
□Yes	□No	Verify OEM has performed internal factory acceptance testing and quality assurance checks prior to FAT and obtain those reports.	
□Yes	□No	Verify approved as-manufactured drawings are present during testing.	
□Yes	□No	Verify equipment datasheets and manuals are present during testing.	
□Yes	□No	Verify meter settings and configuration files are uploaded to meter prior to testing.	
□Yes	□No	Verify communication mapping documentation is present during testing. [Obtain IP address from Owner IT for meter.]	
MECHANICAL INSPECTION			
□Yes	□No	Verify there is no mechanical damage to meter.	
□Yes	□No	Verify there is no liquid damage to meter.	
□Yes	□No	Verify meter frame is grounded in accordance with manufacturer's instructions.	
□Yes	□No	Verify communications cables are connected to meter as shown in the drawings.	
□Yes	□No	Verify fuse blocks and fuse ratings are as rated in the drawings.	
□Yes	□No	Perform point to point check on meter wiring and meter test switch wiring. [Any issues with wiring to be identified via red-lines]	
□Yes	□No	Verify ferrules and lugs are rated and sized correctly per wire gauge.	
□Yes	□No	Perform a pull test on the wiring to ensure that screws, nuts and bolts are tightened and torqued.	
□Yes	□No	Verify wiring bundles do not exceed NFPA 70 requirements.	
□Yes	□No	Verify test switch part number is in accordance with design documentation.	
□Yes	□No	Inspect wiring for pinch points and damage.	
LISTING AND LABELING			
□Yes	□No	Verify phenolic or equivalent labeling is present on meter and associated equipment and that labeling matches drawings.	
□Yes	□No	Verify that all wires are labeled with TO and FROM information.	
□Yes	□No	Verify meter labels match pushbutton and light-emitting diode functionality.	
CURRENT TRANSFORMER CHECKLIST			
□Yes	□No	Record current transformer master ratio and tapped ratio.	

□Yes □No	Verify CT ratings and type match with design documentation.	
□Yes □No	Verify CT is metering type.	
□Yes □No	Verify CT circuit is grounded at only one point.	
POTENTIAL TRANSFORMER CHECKLIST		
□Yes □No	Verify PT circuit is grounded at only one point.	
□Yes □No	Verify secondary side of PT is not shorted.	
□Yes □No	Verify potential transformer ratings and type match with design documentation.	
□Yes □No	Record meter voltage transformer configuration (Open delta, 3W-wye, 4W-wye, etc.).	
METER INSPECTION AND TESTING		
□Yes □No	Record incoming service voltage.	
□Yes □No	Record phase rotation and phasing order. Verify the meter is set correctly based on phase rotation and phasing order.	
□Yes □No	Set the meter in accordance with the engineered settings file.	
□Yes □No	Connect all interconnect wiring for the purposes of testing.	
□Yes □No	Connect temporary control power for the purposes of testing (As required).	
□Yes □No	Record passwords for all meter access levels.	
□Yes □No	Perform secondary current injection testing. Record metered values. -Verify meter reads correct current measurements. Open A-phase current test switch. A-phase Current should measure 0A when the polarity test switch for that phase is open. Close A-phase current test switch. Verify current is seen on meter. Record snapshot of phasor diagrams. -Verify meter reads correct current measurement. Open B-phase current test switch. B-phase Current should measure 0A when the polarity test switch for that phase is open. Close B-phase current test switch. Verify current is seen on meter. Record snapshot of phasor diagrams. -Verify meter reads correct current measurement. Open C-phase current test switch. C-phase Current should measure 0A when the polarity test switch for that phase is open. Close C-phase current test switch. Verify current is seen on meter. Record snapshot of phasor diagrams.	
□Yes □No	Perform secondary three phase current and three phase voltage injection and verify meter reads correct kW, kVA, kVAR, power factor, frequency measurements. Rotate current angle in 30-degree steps and record measured values. Take screenshots of phasor diagrams and graphs for all tests.	
□Yes □No	Record all relevant communications settings and data mapping and ensure settings and data mapping are per design requirements.	
COMMUNICATION INSPECTION AND TESTING		

□Yes □No	Record MAC address, IP address, subnet mask, gateway, BACnet protocol, firmware version.	
□Yes □No	Record communication cable termination location and port number.	
INTEGRATED SYSTEMS TESTING		
□Yes □No	Verify that meter is connected via communications cable back to the building management system.	
□Yes □No	Verify that the building management system is retrieving all required metering data and data is calibrated and reading correctly.	
FINAL INSPECTION		
□Yes □No	Clear the events recorded and meter history.	
□Yes □No	Retrieve “As Left” settings from meter.	
□Yes □No	Verify shorting terminal block screws are not engaged and current transformer are not shorted.	
□Yes □No	Check all fuses are installed and of proper rating.	
□Yes □No	Take pictures of front and back of meter.	
□Yes □No	Take pictures of each switchboard section (front compartments, back compartments and communications compartments).	
□Yes □No	Take pictures of current transformer shorting blocks.	
□Yes □No	Take pictures of test switches.	
□Yes □No	Verify temporary power has been removed from the UPS and switchboard section.	
□Yes □No	Verify grounds and LOTO have been removed.	
□Yes □No	Verify cleanup and housekeeping is complete.	
□Yes □No	Prior to full operation, the general contractor, in the presence of the Meter Commissioning Agent, to perform a complete demonstration and testing of the system operation functions and alarms. Upon successful completion of system operation, the contractor to submit a statement in writing stating that the full operation of all systems, functions, and alarms has been demonstrated and are operational as well as a listing of all systems, alarms, functions that have been commissioned.	
STARTUP AND ENERGIZED CHECKLIST		
□Yes □No	Verify current and voltage metering is correct by connecting to meter and observing phasor data. Take a screenshot and record results.	
□Yes □No	Verify meter communications are operational and recording correct data. Record results.	
□Yes □No	While on site at meter, consult with Owner’s master system integrator (MSI) Analyst to integrate electric meter into existing advanced meter infrastructure system. Ensure that communication to meter is active and that meter is outputting data at correct intervals or on correct registers	

APPENDIX F: SWITCHBOARD, CIRCUIT BREAKER INTEGRATED METERING, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING SWITCHBOARD, CIRCUIT BREAKER INTEGRATED METERING			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Communication settings for the circuit breaker integrated metering and associated communication modules to be set by the on-site third-party testing vendors in collaboration with the on-site IT team. This includes (as applicable): IP addressing, subnet mask, MODBUS register mapping, port settings, baud rate, data speed, data bits, stop, bits, parity, and other relevant communication settings.
2. The on-site third-party testing vendors are responsible for uploading device settings to the meter.
3. Perform the checklist items below for each circuit breaker integrated meter.
4. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

VISUAL AND MECHANICAL INSPECTION [PRE-ENERGIZATION]		
Complete	**Task**	**Comments**
RECORD KEEPING AND DOCUMENTATION		
□Yes □No	Take pictures of meter front, back, nameplate and model information.	
□Yes □No	Record meter model number, style number, serial number, firmware version, software version and control voltage.	
□Yes □No	Verify OEM has performed internal factory acceptance testing and quality assurance checks prior to FAT and obtain those reports.	
□Yes □No	Verify approved as-manufactured drawings are present during testing.	
□Yes □No	Verify equipment datasheets and manuals are present during testing.	
□Yes □No	Verify meter settings and configuration files are uploaded to meter prior to testing.	
□Yes □No	Verify communication mapping documentation is present during testing. [Obtain IP address from Owner IT for meter.]	
MECHANICAL INSPECTION		
□Yes □No	Verify there is no mechanical damage to meter.	
□Yes □No	Verify there is no liquid damage to meter.	
□Yes □No	Verify meter frame is grounded in accordance with manufacturer's instructions.	
□Yes □No	Verify communications cables are connected to meter as shown in the drawings.	
□Yes □No	Inspect wiring for pinch points and damage.	
LISTING AND LABELING		
□Yes □No	Verify phenolic or equivalent labeling is present on meter and associated equipment and that labeling matches drawings.	
□Yes □No	Verify that all wires are labeled with TO and FROM information.	
METER INSPECTION AND TESTING		
□Yes □No	Record incoming service voltage.	
□Yes □No	Verify the meter is set correctly based on phase rotation and phasing order. Record phase rotation and phasing order.	
□Yes □No	Set the meter in accordance with the engineered settings file.	
□Yes □No	Connect all interconnect wiring for the purposes of testing.	
□Yes □No	Connect temporary control power for the purposes of testing (As required).	
□Yes □No	Record passwords for all meter access levels.	
□Yes □No	Perform current injection testing. Record metered values. Take screenshots of metered values.	
□Yes □No	Perform secondary three phase current and three phase voltage injection and verify meter reads correct kW, kVA, kVAR, power factor, frequency measurements. Rotate current angle in 30-degree steps and record measured values. Take	

	screenshots of phasor diagrams and graphs for all tests.	
□Yes □No	Record all relevant communications settings and data mapping and ensure settings and data mapping are per design requirements.	
COMMUNICATION INSPECTION AND TESTING		
□Yes □No	Record MAC address, IP address, subnet mask, gateway, BACnet protocol, firmware version.	
□Yes □No	Record communication cable termination location and port number.	
INTEGRATED SYSTEMS TESTING		
□Yes □No	(Perform for each meter) Verify that meter is connected to communication modules/gateways/servers and routed to the building management system.	
□Yes □No	Verify that the building management system is retrieving all required metering data and data is calibrated and reading correctly.	
FINAL INSPECTION		
□Yes □No	Clear the events recorded and meter history.	
□Yes □No	Retrieve “As Left” settings from meter.	
□Yes □No	Check all fuses are installed and of proper rating.	
□Yes □No	Take pictures of front and back of meter.	
□Yes □No	Take pictures of each switchboard section (front compartments, back compartments and communications compartments).	
□Yes □No	Verify temporary power has been removed from the UPS and switchboard section.	
□Yes □No	Verify grounds and LOTO have been removed.	
□Yes □No	Verify cleanup and housekeeping is complete.	
□Yes □No	Prior to full operation, the general contractor, in the presence of the Meter Commissioning Agent, to perform a complete demonstration and testing of the system operation functions and alarms. Upon successful completion of system operation, the contractor to submit a statement in writing stating that the full operation of all systems, functions, and alarms has been demonstrated and are operational as well as a listing of all systems, alarms, functions that have been commissioned.	
STARTUP AND ENERGIZED CHECKLIST		
□Yes □No	Verify current and voltage metering is correct by connecting to meter and observing metering data. Take a screenshot and record results.	
□Yes □No	Verify meter communications are operational and recording correct data. Record results.	
□Yes □No	While on site at meter, consult with Owner’s master system integrator (MSI) Analyst to integrate electric meter into existing advanced meter infrastructure system. Ensure that communication to meter is active and that meter is outputting data at correct intervals or on correct registers	

APPENDIX G: TRANSFORMER, OIL FILLED, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING TRANSFORMER, OIL FILLED			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

Complete		Task	Comments
VISUAL AND MECHANICAL INSPECTION			
□Yes	□No	Compare equipment nameplate data with drawings and specifications.	
□Yes	□No	Take picture of nameplate and add to testing report.	
□Yes	□No	Inspect physical, electrical, and mechanical condition.	
□Yes	□No	Inspect impact recorder prior to unloading.	
□Yes	□No	Inspect anchorage, alignment, and grounding.	
□Yes	□No	Clean unit	
□Yes	□No	Verify the presence of PCB content labeling.	
□Yes	□No	Verify removal of any shipping bracing after placement.	
□Yes	□No	Clean bushing.	
□Yes	□No	Verify that alarm, control, and trip settings on temperature and level indicators are as specified.	
□Yes	□No	Functionally check operation of alarm, control, and trip circuits from temperature and level indicators pressure relief device, gas accumulator, and fault pressure relay.	
□Yes	□No	Check that cooling fans and pumps rotation is correct, operate correctly and have appropriate overcurrent protection.	
□Yes	□No	Verify all bolted electrical connections have been torqued and marked.	
□Yes	□No	Verify correct liquid level in tanks and bushings.	
□Yes	□No	Verify valves are in the correct operating position.	
□Yes	□No	Install an oil sample valve on the outside pad mount transformers. Use Sunbelt 17888 oil sample kit.	
□Yes	□No	Put positive pressure on nitrogen gas-blanketed transformers of 1 pound.	
□Yes	□No	Perform inspections and mechanical tests as recommended by the manufacturer.	
□Yes	□No	Verify presence of transformer surge arresters.	
□Yes	□No	Verify de-energized tap-changer position is left as specified in the one-line drawings and engineering direction.	
□Yes	□No	Verify all labels are in place (Voltage, LOTO placards, equipment IDs, etc.)	
ACCEPTANCE TESTING			
□Yes	□No	Perform contact resistance testing on bolted electrical connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.	
□Yes	□No	Perform insulation-resistance tests, winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data.	
□Yes	□No	Calculate polarization index. The polarization index to not be less than 1.0.	
□Yes	□No	Perform turns-ratio tests at all tap positions. Turns-ratio test results to not deviate by more than one-half percent from either the adjacent coils or the calculated ratio.	
□Yes	□No	Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer's published data.	

□Yes □No	Perform power-factor or dissipation-factor tests on each bushing equipped with a power factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests. These tests to be in accordance with the test equipment manufacturer's published data.	
□Yes □No	Perform excitation-current tests in accordance with test equipment manufacturer's published data.	
□Yes □No	Measure the resistance of each winding at each tap connection. Test current not to exceed 10 percent rated current according to IEEE C57.152. Results < 1% of rated name plate current	
□Yes □No	If core ground strap is accessible, remove and measure core insulation resistance. Test Voltage: 500VDC, Test results > 500 megohms.	
□Yes □No	Remove a sample of insulating liquid in accordance with ASTM D923. Oil Samples will be shipped to SdMyers at 180 South Avenue, Tallmadge OH 44278 and reference Owner account number 1551469. For international orders ship to: Testmark Laboratories 6820 Kitimat Road, Unit #4 Mississauga, ON L5N 5M3 Canada. a. Dielectric breakdown voltage: ASTM D1816 b. Acid neutralization number: ASTM D974 c. Specific gravity: ASTM D1298 d. Interfacial tension: ASTM D971 e. Color: ASTM D1500 f. Visual Condition: ASTM D1524 g. Water in insulating liquids: ASTM D1533. h. Power factor or dissipation factor in accordance with ASTM D924. i. Remove a sample of insulating liquid in accordance with ASTM D923 and perform dissolved-gas analysis (DGA) in accordance with IEEE C57.104 or ASTM D3612.	
□Yes □No	Test instrument transformers in accordance with procedure outlined in this document.	
□Yes □No	Test surge arresters in accordance with procedure outlined in this document.	
□Yes □No	Verify operation of cubicle or air terminal compartment space heaters (if applicable).	
□Yes □No	Adjust transformer taps in accordance with the power system study recommendations. If the power system study has not been performed, then adjust taps to be within 5% of the rated secondary voltage. Any tap adjustments to be approved by the Engineer of Record, documented and submitted as part of the final report.	

APPENDIX H: METERING DEVICE, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING METERING DEVICE			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

Complete		Task	Comments
VISUAL AND MECHANICAL INSPECTION			
□Yes	□No	Compare equipment nameplate data with drawings and specifications.	
□Yes	□No	Take picture of nameplate and add to testing report.	
□Yes	□No	Inspect meters and cases for physical damage.	
□Yes	□No	Record model number, serial number, firmware revision, software revision, and rated control voltage.	
□Yes	□No	Verify Instrument transformer ratio.	
□Yes	□No	Verify tightness of electrical connections.	
□Yes	□No	Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case-shorting contacts, as applicable.	
□Yes	□No	Clean unit.	
□Yes	□No	Verify freedom of movement, end play, and alignment of rotating disk(s).	
□Yes	□No	Verify operation of display and indicating devices.	
□Yes	□No	Record passwords.	
□Yes	□No	Verify unit is grounded in accordance with manufacturer's instructions.	
□Yes	□No	Verify unit is connected in accordance with manufacturer's instructions and project drawings.	
□Yes	□No	Set all required parameters including instrument transformer ratios, system type, frequency and power demand methods/intervals, and communications requirements.	
□Yes	□No	Verify approved as-manufactured drawings are present during testing.	
□Yes	□No	Verify equipment datasheets and manuals are present during testing.	
□Yes	□No	Verify meter settings and configuration files are uploaded to meter prior to testing.	
□Yes	□No	Verify communication mapping documentation is present during testing.	
□Yes	□No	Perform point to point check on meter wiring and meter test switch wiring. [Any issues with wiring to be identified via red-lines]	
□Yes	□No	Verify ferrules and lugs are rated and sized correctly per wire gauge.	
□Yes	□No	Perform a pull test on the wiring to ensure that screws, nuts and bolts are tightened and torqued.	
□Yes	□No	Inspect wiring for pinch points and damage.	
CURRENT TRANSFORMER CHECKLIST			
□Yes	□No	Record current transformer master ratio and tapped ratio.	
□Yes	□No	Verify CT ratings and type match with design documentation.	
□Yes	□No	Verify CT is metering type.	
□Yes	□No	Verify CT circuit is grounded at only one point.	
POTENTIAL TRANSFORMER CHECKLIST			
□Yes	□No	Verify PT circuit is grounded at only one point.	
□Yes	□No	Verify secondary side of PT is not shorted.	
□Yes	□No	Verify potential transformer ratings and type match with design documentation.	

□Yes □No	Record meter voltage transformer configuration (Open delta, 3W-wye, 4W-wye, etc.).	
ACCEPTANCE TESTING		
□Yes □No	Record incoming service voltage.	
□Yes □No	Record phase rotation and phasing order. Verify the meter is set correctly based on phase rotation and phasing order.	
□Yes □No	Set the meter in accordance with the engineered settings file.	
□Yes □No	Record passwords for all meter access levels.	
□Yes □No	Perform secondary three phase current and three phase voltage injection and verify meter reads correct kW, kVA, kVAR, power factor, frequency measurements. Rotate current angle in 30-degree steps and record measured values. Take screenshots of phasor diagrams and graphs for all tests.	
□Yes □No	Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.	
□Yes □No	Confirm correct operation and setting of each auxiliary input/output feature in use, including mechanical relay, digital, and analog.	
□Yes □No	Record all relevant communications settings and data mapping and ensure settings and data mapping are per design requirements.	
COMMUNICATION INSPECTION AND TESTING		
□Yes □No	Record MAC address, IP address, subnet mask, gateway, BACnet protocol, firmware version.	
□Yes □No	Record communication cable termination location and port number.	
□Yes □No	Verify that meter is connected via communications cable back to the building management system.	
□Yes □No	Verify that the building management system is retrieving all required metering data and data is calibrated and reading correctly.	
FINAL INSPECTION		
□Yes □No	Clear the events recorded and meter history.	
□Yes □No	Retrieve “As Left” settings from meter.	
□Yes □No	Take pictures of front and back of meter.	
□Yes □No	Verify cleanup and housekeeping is complete.	
□Yes □No	Prior to full operation, the general contractor, in the presence of the Meter Commissioning Agent, to perform a complete demonstration and testing of the system operation functions and alarms. Upon successful completion of system operation, the contractor to submit a statement in writing stating that the full operation of all systems, functions, and alarms has been demonstrated and are operational as well as a listing of all systems, alarms, functions that have been commissioned.	
STARTUP AND ENERGIZED CHECKLIST		
□Yes □No	Verify current and voltage metering is correct by connecting to meter and observing phasor data. Take a screenshot and record results.	

□Yes □No	Verify meter communications are operational and recording correct data. Record results.	
□Yes □No	While on site at meter, consult with Owner's master system integrator (MSI) Analyst to integrate electric meter into existing advanced meter infrastructure system. Ensure that communication to meter is active and that meter is outputting data at correct intervals or on correct registers	

APPENDIX I: AUTOMATIC TRANSFER SWITCH, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING AUTOMATIC TRANSFER SWITCH			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Obtain automatic transfer switch configuration/settings file.
2. Obtain OEM drawings for automatic transfer switch.
3. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

Complete	Task	Comments
VISUAL AND MECHANICAL INSPECTION		
□Yes □No	Compare equipment nameplate data with drawings and specifications.	
□Yes □No	Take picture of nameplate and add to testing report.	
□Yes □No	Inspect anchorage, alignment, grounding, and required area clearances.	
□Yes □No	Verify all shipping bracing, loose parts, and documentation shipped inside cubicles has been removed.	
□Yes □No	Clean unit.	
□Yes □No	Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.	
□Yes □No	Verify that manual transfer warnings are attached and visible.	
□Yes □No	Verify tightness of all control wiring connections by tug test and spot checking with screw driver.	
□Yes □No	Verify all bolted electrical connections have been torqued and marked.	
□Yes □No	Perform manual transfer operation.	
□Yes □No	Verify positive mechanical interlocking between normal and alternate sources.	
□Yes □No	Verify neutral cable from all sources are correctly connected at source side and at ATS.	
□Yes □No	Verify all labels are present (AF, voltage, equipment ID, LOTO, etc.)	
ACCEPTANCE TESTING		
□Yes □No	Perform insulation resistance tests on each pole, phase-to-phase and phase-to-ground with switch in both source positions and across each open pole. Test voltage to be in accordance with manufacturer's published data.	
□Yes □No	Perform contact resistance testing on bolted electrical connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.	
□Yes □No	Perform a contact/pole-resistance test. A, B, C and N connections should not deviate by more than 50 percent of the lowest value from either Normal/Utility or Emergency/Alternative	
□Yes □No	Calibrate and set all relays and timers. (As needed).	
□Yes □No	Verify phase rotation, phasing, and synchronized operation for all sources of power.	
□Yes □No	Verify setting are correct and document settings of operation and timing of the following functions: a) Normal source voltage-sensing and frequency-sensing relays. b) Engine start sequence. c) Time delay upon transfer. d) Alternate source voltage-sensing and frequency-sensing relays. e) Automatic transfer operation. f) Interlocks and limit switch function. g) Time delay and retransfer upon normal power restoration.	

	h) Engine cool down and shutdown feature.	
□Yes □No	Complete a function testing in the form of a transfer once equipment is energized.	

APPENDIX J: GROUNDING SYSTEM, ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING GROUNDING SYSTEM			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

Complete	Task	Comments
VISUAL AND MECHANICAL INSPECTION		
□Yes □No	Verify ground system is in compliance with drawings, specifications, and NFPA 70, National Electrical Code, Article 250.	
□Yes □No	Inspect physical and mechanical condition.	
□Yes □No	Inspect that neutral is only bonded to ground at main service equipment or at secondary of Transformers.	
ACCEPTANCE TESTING		
□Yes □No	Perform fall–of–potential or alternative test in accordance with IEEE 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground to be < 5 ohms for large commercial or industrial systems.	
□Yes □No	Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.	
□Yes □No	Perform point to point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral and device neutral points. Investigate point to point resistance values that exceed 0.5 ohms.	

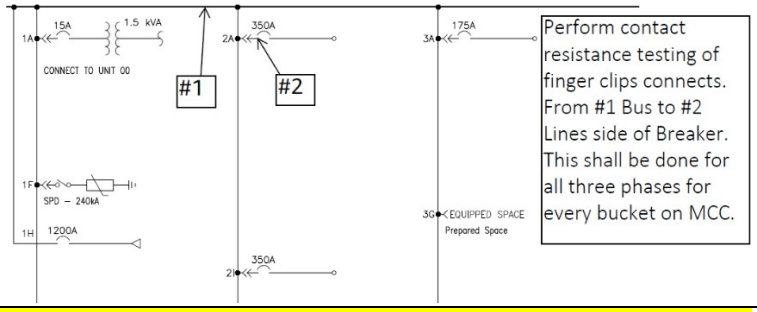
APPENDIX K: MOTOR CONTROL CENTER (MCC), ACCEPTANCE TESTING

ELECTRICAL ACCEPTANCE TESTING MOTOR CONTROL CENTER			
Equipment Information			
Equipment Tag No.:		Manufacturer:	
Equipment Location:		Model Number:	
Project/Site Information			
Project:		Site Region:	
Room Name:		Site Code:	
Completed By			
GC Company:		3PTV Company:	
GC Name:		3PTV Lead Name:	
GC Phone Number:		3PTV Lead Phone Number:	

Notes:
1. Follow manufacturers expected test values during electrical testing. If manufacturer expected test values are absent from manufacturers literature, then follow NETA ATS or associated IEEE standard to determine acceptance testing expected values.

Comments:

Complete		Task	Comments
VISUAL AND MECHANICAL INSPECTION			
□Yes	□No	Compare equipment nameplate data with drawings and specifications.	
□Yes	□No	Take picture of nameplate and add to testing report.	
□Yes	□No	Inspect physical, electrical, and mechanical condition of cords and connectors.	
□Yes	□No	Inspect anchorage, alignment, grounding, and required area clearances.	
□Yes	□No	Clean unit	
□Yes	□No	Verify all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.	
□Yes	□No	Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker address for microprocessor-communication packages.	
□Yes	□No	Verify that current and voltage transformer ratios correspond to drawings.	
□Yes	□No	Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.	
□Yes	□No	Verify all bolted electrical connections have been torqued and marked.	
□Yes	□No	Confirm correct operation and sequencing of electrical and mechanical interlock systems. • Attempt closure on locked-open devices. Attempt to open locked-closed devices. • Make key exchange with all devices included in the interlock scheme.	
□Yes	□No	Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.	
□Yes	□No	Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.	
□Yes	□No	Inspect insulators for evidence of physical damage or contaminated surfaces.	
□Yes	□No	Verify correct barrier and shutter installation and operation.	
□Yes	□No	Exercise all active components.	
□Yes	□No	Inspect mechanical indicating devices for correct operation.	
□Yes	□No	Verify that filters are in place and vents are clear.	
□Yes	□No	Perform visual and mechanical inspection of instrument transformers in accordance with this document.	
□Yes	□No	Perform visual and mechanical inspection of surge arresters in accordance with this document.	
□Yes	□No	Perform visual and mechanical inspection of microprocessor relays in accordance with this document. .	
□Yes	□No	Perform visual and mechanical inspection of control power transformers in accordance with this document.	
□Yes	□No	Use wiring schematic to perform a functional checkout on control wiring. • Use printed out drawings, laptop, or I-pad to highlight wiring schematic once it has been verified	
□Yes	□No	Verify all correct labeling is installed (AF, LOTO Placards, Etc.)	
ACCEPTANCE TESTING			
□Yes	□No	Perform contact resistance testing on bolted electrical connections. Investigate values which deviate from those of	

	similar bolted connections by more than 50 percent of the lowest value. Complete all horizontal and vertical sections.	
□Yes □No	Perform contact resistance testing from bus thought finger clips of each bucket that is installed on MCC. The contact resistance should be no greater than 50% of the lowest reading between A, B, and C phases. 	
□Yes □No	Perform insulation-resistance tests for each bus section, phase-to-phase and phase-to-ground. Apply voltage in accordance with manufacturer's published data.	
□Yes □No	Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data.	
□Yes □No	Perform electrical tests on instrument transformers in accordance with procedure outlined in this document.	
□Yes □No	Perform ground-resistance tests in accordance with procedure outlined in this document.	
□Yes □No	Test metering devices in accordance with procedure outlined in this document.	
□Yes □No	Test control power transformers in accordance with procedure outlined in this document.	
□Yes □No	Test voltage transformers in accordance with procedure outlined in this document.	
□Yes □No	Test microprocessor relays in accordance with procedure outlined in this document.	
□Yes □No	Verify operation of cubicle switchgear/switchboard space heaters and their controller.	
□Yes □No	Perform electrical tests of surge arresters in accordance with procedure outlined in this document.	

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following lighting control devices:

1. Line-voltage dimming wall switches.
2. Line-voltage wall switch occupancy sensors.
3. Line-voltage dimming wall switch occupancy sensors.
4. Stand-Alone Low-voltage occupancy sensors.
5. Stand-Alone Low-voltage photoelectric switches.
6. Stand-Alone Low-voltage power packs.
7. Stand-Alone Low-voltage switches.
8. Outdoor motion sensors.
9. Time switches.
10. Lighting contactors.
11. Conductors and Cables for Lighting Control Devices.

1.2 DEFINITIONS

A. Acoustic Type: Occupancy sensor detection type that detects occupancy by listening for acoustic noises.

B. Closed loop: Photosensor control algorithm designed for influence by both daylight and electric light in a space or area.

C. DPDT: Double pole, double throw.

D. DPST: Double pole, single throw.

E. Dual-Technology Type: Occupancy sensor detection type that detects occupancy by using a combination of PIR and ultrasonic or acoustic detection technologies.

F. LED: Light-emitting diode.

G. Open loop: Photosensor control algorithm designed for influence by daylight entering in a space or area.

H. PIR Type: Passive infrared. Occupancy sensor detection type that detects occupancy by sensing a combination of infrared heat and movement.

I. SPST: Single pole, single throw.

J. Ultrasonic Type: Occupancy sensor detection type that detects occupancy by sensing a change in pattern of reflected ultrasonic energy.

1.3 ADMINISTRATIVE REQUIREMENTS

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.

1.4 PERFORMANCE SPECIFICATIONS FOR SUSTAINABILITY GOALS

A. Occupancy Sensor Operation:

1. When motion is detected turn light fixtures on to 100% power output.
2. In Warehouse shelving areas, after 5 minutes of no activity reduce to 10% power output.
3. In Warehouse shelving areas, after 15 minutes of no activity turn fixtures off.
4. In all other areas, after 5 minutes of not activity, reduce to 50% output, then after 15 minutes of no activity turn fixtures off.

1.5 SUBMITTALS

A. Product data for the following products:

1. Catalog cut sheets, including major and minor motion coverage patterns sensors, time delay and sensitivity adjustability settings, load restrictions, and performance specification items indicating compliance with this specification for all lighting control devices.

B. Shop Drawings:

1. Occupancy sensors and photoelectric switches

a. Show installation details.
b. Lighting plan showing location, mounting height, orientation and coverage area of each sensor and coordination with other trades.
c. Interconnection diagrams showing field-installed wiring.
d. Include diagrams for power, signal, and control wiring.
e. For any manufacturer submitted other than that listed as the Basis of Design, provide the following information for Engineer review:

1) Factory-generated occupancy sensor and photoelectric switch layouts on project lighting plans with sensor location, orientation and product type clearly marked on plans. Sensor placement shall be coordinated with project reflected ceiling plan layout, ceiling heights, lights, diffusers, and any other ceiling devices and equipment.
2) List of any deviations to this specification or Basis of Design products.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. Occupancy sensors and photoelectric switches:

a. Manufacturer’s installation instructions, including instructions for storage, handling, protection, examination, preparation, start-up calibration and installation.
b. Product data clearly showing sensor field adjustments, including dip switch setting definitions and location of settings within sensors.
c. Manufacturer’s maintenance, including operating and adjustment instructions.

2. Timeclocks

a. Description of programmed timeclock settings at time of substantial completion.

3. Line-voltage wall box dimming switches

a. Provide operating instructions for each type of dimmer.

1.6 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. Occupancy sensors and photoelectric switches

1. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of 5 years.
2. Products shall be manufactured by an ISO 9001 certified manufacturing facility.
3. Manufacturer shall test all equipment prior to shipment.

1.7 WARRANTY

A. Manufacturers shall provide a five (5) year warranty for sensors and accessories from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL INFORMATION

A. PIR type requirements:

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. Sensor shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
3. Sensor shall provide high immunity to false triggering from RFI and EMI.
4. Sensor shall have a multiple-segmented fresnel lens in a multiple-tier configuration, with grooves to eliminate dust and residue buildup. Sensor shall be capable of accepting mask inserts to mask specific portions of the lens to prevent false triggering.

B. Ultrasonic type requirements:

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 Frequency (Small Area – 500 sq ft and less): Ultrasonic operating frequency shall be crystal controlled at 40 kHZ within +/- 0.005% tolerance to assure reliable performance and eliminate sensor cross-talk.
3. Detection Frequency (Medium and Large Areas – greater than 500 sq ft): Ultrasonic operating frequency shall be crystal controlled at 32 kHz within +/- 0.005% tolerance, to assure reliable performance and eliminate sensor cross-talk.
4. Sensors shall be capable of automatically adapting to airflow conditions or filtering frequency spectrum related to air movement.

C. Acoustic type requirements:

1. Detector Sensitivity: Acoustic type technology shall only be used as secondary to PIR in a Dual-Technology Type sensor. Specific sensitivity is based on PIR technology.
2. Sensors shall distinguish noises made by human activity (typing, talking, eating, etc.) and filter out noises made by the environment or building (HVAC, equipment, cars, etc.).

3. Acoustic technology shall enhance reliability and accuracy of PIR sensor.

D. Dual-Technology type requirements:

1. Dual-Technology sensors using ultrasonic technology shall have field-selectable controls on unit to determine if a particular technology or combination of technologies controls the on-off function.
2. Dual-Technology sensors using acoustic technology shall have the PIR technology initially detect motion and a combination of PIR and acoustic technologies shall keep the load on.
3. Sensitivity Adjustment: Separate for each sensing technology.
4. Different LED indicator colors for each sensing technology
5. PIR sensor component shall comply with all requirements listed under PIR type requirements.
6. Ultrasonic sensor component shall comply with all requirements listed under Ultrasonic Type requirements.
7. Acoustic sensor component shall comply with all requirements listed under Acoustic Type requirements.

2.2 LINE-VOLTAGE DIMMING WALL SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. Dimmer shall be suitable for dimmed load type of connected light fixture. Load types shall be as indicated on Drawings and confirmed per load type for connected luminaire as indicated in Light Fixture Schedule and approved light fixture and dimmer shop drawings.

2.3 LINE VOLTAGE WALL SWITCH OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for Sensors:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C), unless indicated elsewhere for specific model and application.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.

    a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
    b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of the switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.

5. Operation adjustment: Concealed, field-adjustable for auto-on or manual-on operation.
6. Time Delay adjustment:

    a. Concealed, field-adjustable.

b. Time delay for de-energizing loads shall be adjustable with multiple increments from 30 seconds up to 20 minutes.

7. Adaptive technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false “off” switching.
8. Mounting: Single-gang wall box switch
9. Finish: Sensor finish shall be as indicated on the Drawings.
10. Sensor:

    a. vandal-resistant lens
    b. integral sliding blinders or pre-cut tape strips to block sensor views
    c. protrudes no greater than 0.50 inches from wall.
    d. 180-degree field of view
    e. major and minor motion coverage patterns confirmed per Nema WD7 guidelines.
    f. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.

11. Indicators:

    a. LED indicator for visual detection of motion
    b. audible and/or visual alerts for pending shut-off

12. Suitable for switching load types used, including LED, fluorescent, incandescent, magnetic and electronic low voltage and motor load types. UL listed and labeled, zero-cross relay, no minimum load requirement, ground wire.
13. Wall switch shall have no leakage of current to load and integral service switch to permit a maintained off for servicing of lamps for safety purposes
14. Buttons/Relays: Provide control relay and push button quantities as indicated by model listed in Lighting Control Device Schedule.
15. Restriction on leakage to grounding conductor.

    a. For new construction: Dual-technology wall switch sensor shall have not more than 0.5ma leakage of current to ground per UL requirements. Provide and connect a neutral conductor to these devices.
    b. For remodel projects and where indicated specifically on plans, dual-technology wall switch sensors, where the manufacturer does not require a neutral conductor to device and does not have more than 0.5ma leakage of current to ground per UL requirements, are not required to have a neutral conductor connected to them. Manufacturers that do not comply with the abovementioned UL requirements are not acceptable.

2.4 LINE-VOLTAGE DIMMING WALL SWITCH OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for Sensors:

1. Comply with all requirements listed under Line-Voltage Dimming Wall Switches in this specification and,
2. Comply with all requirements listed under Line-Voltage Wall Switch Occupancy Sensors in this specification.

2.5 STAND-ALONE LOW-VOLTAGE OCCUPANCY/VACANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensor unit, for use with a separate stand-alone low-voltage power pack containing a line-voltage relay.

1. Occupancy sensors and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. UL Listed for dry locations and complies with local codes.
4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.

    a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
    b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of a separate, associated switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.

5. Switch Rating: As indicated in Lighting Control Device Schedule.
6. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.
7. Mounting: Suitable for mounting in any position on a standard outlet box.
8. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
9. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.
10. Bypass Switch: Override the “on” function in case of sensor failure, concealed on unit to prevent tampering.
11. Finish: Sensor finish shall be as indicated on the Drawings.
12. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.
13. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.
14. Sensors:

    a. Sensor shall be compatible with lighting control system.
    b. Sensors shall be capable of being combined with additional sensors to achieve adequate coverage.
    c. Sensor coverage pattern: AS indicated on Lighting Control Device Schedule, and shall have been confirmed with Nema WD7 Guide and Robotic test method.
    d. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.

C. High-Bay Model:

1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.

2.6 STAND-ALONE LOW-VOLTAGE PHOTOELECTRIC SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for switches: Ceiling-mounted, solid-state indoor photoelectric switch, for use with a separate stand-alone low-voltage power pack, containing a line-voltage relay.

1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. UL Listed for dry locations and complies with local codes.
4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Upon ambient light level measurement reading below setpoint, loads shall be de-energized. Upon ambient light level measurement reading above setpoint, loads shall be energized.
5. Finish: Sensor finish shall be as indicated on the Drawings.

C. Indoor:

1. Photoelectric switches shall be Open Loop or Closed Loop as indicated on the Lighting Control Device Schedule on the Drawings.
2. Description: Solid state, low voltage with contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the lighting control system or as indicated on the Drawings.

    a. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
    b. Time Delay: 30-second minimum, to prevent false operation.
    c. Mounting: Twist lock complying with IEEE C136.10, with base.

D. Outdoor:

1. Description: Solid state, low voltage with contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered indicated on the Drawings.

    a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
    b. Time Delay: 30-second minimum, to prevent false operation.
    c. Lightning Arrester: Air-gap type.
    d. Mounting: Twist lock complying with IEEE C136.10, with base.

2.7 STAND-ALONE LOW-VOLTAGE POWER PACKS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for power packs: Box mounted, solid-state indoor power pack/relay unit, for use with a separate stand-alone low-voltage sensor and switches.

1. Power packs and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. UL Listed for dry locations and complies with local codes.
4. Unit shall include isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems as indicated on the Drawings
5. Relay shall be compatible with the specific lighting types controlled.
6. Operations: Refer to drawings for Sequence of Operations or other operational instructions. Unit operates in conjunction with other system components. Refer to operations requirements of associated devices.
7. Switch Rating: As indicated in Lighting Control Device Schedule.
   Mounting: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

2.8 STAND-ALONE LOW-VOLTAGE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for switches: Wall-mounted, solid-state indoor manual switch, for use with a separate stand-alone low-voltage power pack, containing a line-voltage relay.

1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. UL Listed for dry locations and complies with local codes.
4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Manual push of any button shall energize or de-energize loads.
5. Mounting: Suitable for mounting in any position on a standard outlet box.
6. Indicator: LED, for each button to indicate when loads are energized and de-energized.
7. Finish: Sensor finish shall be as indicated on the Drawings.
8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

2.9 OUTDOOR MOTION SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for Sensors: Solid-state outdoor motion sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Weatherproof, detection technology as indicated in the Lighting Control Device Schedule on the Drawings.
3. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.

4. Detection Coverage: As indicated in Lighting Control Device Schedule on the Drawings.
5. Switch Rating: Line Voltage: Minimum 1000-W incandescent and 500-VA ballast load at 120-V ac; 1000W ballast load at 277-V ac. Voltage as indicated on Drawings and Lighting Control Device Schedule.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 1 to 20 FC. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector with multiple increments from 30 seconds up to 15 minutes.
8. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 14 to plus 130 deg F, rated as "rain tight" according to UL 773A.
9. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outdoor junction box and ½" threaded nipple for use with standard NEMA weatherproof fixture fitting.
    b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

10. Bypass Switch: Override the on function in case of sensor failure.

2.10 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Intermatic, Inc.
3. Leviton Mfg. Company Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Paragon Electric Co.; Invensys Climate Controls.
6. Square D; Schneider Electric.
7. TORK; NSI Industries.
8. Wattstopper; a Legrand Company.

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPST.
2. Contact Rating: 30-A inductive or resistive, 240-V ac, 20-A ballast load, 120/240-V ac.
3. Program: 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
4. Circuitry: Allow connection of a photoelectric switch relay as substitute for on-off function of a program.
5. Astronomic Time: All channels.
6. Battery Backup: For schedules and time clock.

2.11 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. GE Industrial Systems; Total Lighting Control.
4. Hubbell Lighting.
5. Lithonia Lighting; Acuity Lighting Group, Inc.

6. Square D; Schneider Electric.
7. TORK; NSI Industries.

B. Description: Electrically operated and mechanically held, combination type with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including LED 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. Refer to FCA value on drawings, at nearest upstream device.
3. Enclosure: Provide with enclosure complying with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.12 CONDUCTORS AND CABLES FOR LIGHTING CONROL DEVICES

A. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.

B. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG.

C. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG.

D. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG.

E. Provide all necessary conductor and cabling required for operation of the controls and control systems specified. This includes power and control wiring required for the controls to operate as described.

PART 3 - EXECUTION

3.1 INSTALLATION

A. GENERAL

1. Install devices and associated power packs and wiring in accordance with manufacturer’s instructions and applicable codes.

B. LINE VOLTAGE WALL SWITCHES

1. Install dimming wall switches to achieve full rating specified on Lighting Control Device Schedule taking into account de-rating for ganging as instructed by the manufacturer.
2. Provide a separate grounded (neutral) conductor for each circuit controlled by a line voltage switch.

a. Do not share neutral conductor on load side of dimmers.
b. If neutral termination is not required for the device, cap conductor and tag as “Neutral for future use”.

C. OCCUPANCY/VACANCY SENSORS AND PHOTOELECTRIC SWITCHES

1. Arrange a pre-installation meeting with manufacturer’s factory authorized field representative, at Owner’s facility, to verify placement of sensors and installation criteria.
2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage areas specified in manufacturer's literature. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas that are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective areas.
3. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems and partition assemblies.
4. Occupancy sensors with ultrasonic or dual-technology sensing technologies shall be located not closer than 4 feet from the nearest edge of air supply devices or similar obstructions that would adversely affect the sensor performance.
5. Adjust time delay setting of occupancy sensors to de-energize loads after space has been unoccupied for period of time indicated on the Drawings.
6. Install outdoor photoelectric switches with clear view of the northern sky unless noted otherwise on the Drawings.
7. Adjust settings of photoelectric switches to turn on lighting at illumination level indicated on the Drawings.
8. Install devices and auxiliary equipment in compliance with manufacturer’s instructions and recommendations.
9. Install relay units where concealed from view and where accessible.
10. 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.
11. Install switchbox mounted occupancy sensors at same elevation as other lighting control switches.

D. TIME SWITCHES

1. Install time switches in locations as indicated on the Drawings.
2. Program time switches with current time and date information in accordance with manufacturer’s instructions.
3. Program timeclock settings as per Sequence of Operations on the Drawings. Confirm final timeclock settings with Owner prior to programming.

E. LIGHTING CONTACTORS

1. Install lighting contactors in locations as indicated on the Drawings.
2. Provide NEMA 1 enclosures for lighting contactors in interior dry locations, NEMA 3R enclosures for lighting contactors in exterior or wet locations.
3. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

F. WIRING

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
4. 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. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."

B. Power and control wiring: Identify using marker tapes.

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric switches and occupancy sensors at each sensor.

C. Components: Label each component with self-laminating computer printed labels, using a unique designation matching control drawing.

D. Cover plates: Refer to drawings for labeling requirements of certain cover plates for manual switches, or similar devices, requiring labeling for user information.

E. Buttons/switches:

1. Engraved from manufacturer. Refer to drawings for detailed requirements and text for labeling.

3.3 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: Test all occupancy sensors in test mode to confirm sensor coverage and sensitivity of sensor per manufacturer’s instructions. Upon completion of tests, set sensor time delay as indicated on Lighting Control Device Schedule. Follow testing and adjustment procedures as written in the manufacturer’s installation instructions for each sensor model.

B. Lighting control devices that fail tests and inspections are defective work. Remove, replace, and retest devices that fail tests.

3.4 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.

B. Photoelectric switch 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 for this purpose.

3.5 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Lighting Control Systems."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section

"Demonstration and Training" and Division 26 Section "Lighting Control Systems" for additional information.

END OF SECTION 260923

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PART 1 - SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 2 - GENERAL

2.1 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1500 kVA:

1. Distribution transformers.

2.2 ADMINISTRATIVE REQUIREMENTS

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

2.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, technical certification sheets and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Transformer ratings including:

a. kVA
b. Primary and secondary voltage
c. Taps
d. Basic impulse level (BIL) for equipment over 600 volts
e. Design impedance
f. Insulation class and temperature rise
g. Sound level.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

2.4 QUALITY ASSURANCE

A. 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.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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 IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

E. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".

F. All transformers shall be UL listed and bear the UL label.

2.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

2.6 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 “Seismic Controls for Electrical Systems” and Division 20 Section “Seismic Controls for MEP/F/T Systems”.

PART 3 - PRODUCTS

3.1 GENERAL TRANSFORMER REQUIREMENTS

A. Manufacturers:

1. ACME Electric Corporation; Power Distribution Products Division
2. Eaton Electrical Inc.; Cutler-Hammer Products.
3. General Electric Company.
4. Hammond Company
5. Siemens Energy & Automation, Inc.
6. Sola/Hevi-Duty
7. Square D; Schneider Electric.

B. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

C. Cores: One leg per phase. Cores shall be constructed of high grade, non-aging silicon steel. The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber, vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor or strap sized in accordance with UL and NEC requirements. The neutral shall be brought to a stud to facilitate the required external grounding of the secondary

D. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Aluminum.

E. Connections to transformers shall be by flexible metal conduit and using flexible couplings.

F. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

G. Wiring/Terminations:

1. Recommended external cable shall be rated 90 degrees C (sized at 75 degrees C ampacity) for encapsulated and 75 degrees C for ventilated designs.
2. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.
3. Lug kits shall be provided by the Manufacturer of the transformer.

3.2 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Enclosures: Unless otherwise specified, transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. Enclosures shall have a baked polyester powder coat finish-gray in color and suitable for interior or exterior applications. Enclosures shall be constructed so that there are no exposed live parts. Enclosures shall have a removable front cover to allow access to internal parts and wiring terminations

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
2. Transformer locations:

a. Dry locations:

1) Ventilated
2) NEMA 250, Type 2.

b. Damp or wet:

1) Ventilated. Provide weather shields over ventilation openings.
2) NEMA 250, Type 3R.

3. The maximum temperature of the enclosure shall not exceed 90 degrees C.
4. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.

C. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 61 gray.

D. Taps

1. Three-phase Transformers smaller than 24 kVA and all single phase transformers:

a. One 5 percent tap above and one 5 percent tap below normal full capacity
b. Two 5 percent taps below rated voltage.

2. Transformers 25 kVA through 500 kVA:

a. Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

E. Insulation Class for transformers less than 15 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

F. Insulation Class for transformers 15 kVA and larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature

G. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment" efficiency levels.
2. Tested in accordance with federal law 10 CFR Part 431.

H. Mounting Methods.

1. Transformers shall be floor mounted unless indicated otherwise. Floor mounted transformers shall be securely bolted to a 4 inch house keeping pad with vibration isolation pads.
2. Transformers up through 1000 KVA shall be mounted on elastomeric vibration isolation pads. Pad shall be constructed of neoprene, rubber, glass fiber, or a combination thereof. Pads shall be “ribbed” or “waffled” in texture. Pads shall be selected for smallest durometer (hardness), preferably less than 50. Deflection of pad shall be .25” static minimum. Stack pads until the desired deflection is achieved.
3. Wall Mounting: Manufacturer's standard brackets.
4. Suspended Mounting: See transformer mounting detail on plans.

I. Low-Sound-Level Requirements: Maximum sound levels (NEMA ST 20), when factory tested according to IEEE C57.12.91, as follows:

1. 30 to 50 kVA: 45 dBA
2. 51 to 150 kVA: 50 dBA

3.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

3.4 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to ANSI C57.12.01 and IEEE C57.12.91.

3.5 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. Ratio tests at the rated voltage connection and at all tap connections
2. Polarity and phase relation tests on the rated voltage connection
3. Applied potential tests
4. Induced potential test
5. No-load and excitation current at rated voltage on the rated voltage connection

PART 4 - EXECUTION

4.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

4.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Floor mounted transformers shall be mounted on a 4 inch concrete housekeeping pad 2 inches larger all around transformer.

C. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

D. Use flexible conduit under the provisions of Division 26 Section “Raceways and Boxes for Electrical Systems” for connections to transformer case. Minimum flexible conduit length shall be two (2) feet.

E. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

4.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

4.4 IDENTIFICATION

A. Nameplates: Label each transformer with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems." Nameplates shall be engraved with the following information.

1. Transformer name
2. Fed from (primary source)
3. Secondary voltage, phase, wires

B. Warning Labels: Label each panelboard with a warning label indicating NFPA 70 workspace clearance requirements, complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

4.5 FIELD QUALITY CONTROL

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. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

4.6 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

4.7 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes switchboards rated 600 V and less, including the following:

1. Service and distribution switchboards.
2. Surge Protection Devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.

C. SPD: Surge Protection Device

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies”

D. Coordinate active arc flash mitigation system connection requirements for service main breaker. Coordinate commissioning off the active arc flash mitigation system with owner-approved commissions agent.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include

dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

C. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.

    a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Include outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
5. Detail short-circuit current rating of switchboard assembly and overcurrent protective devices.
6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
7. Detail utility company's metering provisions with indication of approval by utility company.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include schematic and wiring diagrams for power, signal, and control wiring.
10. Include nameplate legends.
11. Include list of materials.

D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1. For each equipment room, provide dimensioned layout of the electrical equipment within the space, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
2. Dimensioned concrete base, outline of switchboard, conduit entries, and ground rod locations; including equipment working clearances and manufacturer required access space.
3. Indicate structural members, light fixtures, sprinkler piping and heads, HVAC equipment, ducts and diffusers, plumbing piping and access fittings. Include maintenance access clearances.
4. Location of structural supports for structure-supported raceways and seismic bracing.
5. Location and clearance of electrical equipment and raceways impacting equipment installation.

E. Seismic Qualification Data: For panelboard equipment, accessories, and components, from manufacturer.

1. Certificate of compliance.
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.

F. Qualification Data: For qualified Installer and testing agency.

G. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

H. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

I. Operation and Maintenance Data: For switchboards 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 switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
4. Features and operating sequences, both automatic and manual.
5. Video recording of operation training and demonstration.

J. Follow-up service reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E; Employs installers and supervisors who are trained and approved by manufacturer.

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. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

D. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

F. 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.

G. Comply with NEMA PB 2.1.

H. Comply with NFPA 70.

I. Comply with UL 891.

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not install switchboards until spaces are enclosed and weathertight. Equipment shall be protected from any remaining wet work in the space and work above secondary unit substation. Provide temporary HVAC system for maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

3. Service Conditions: NEMA PB 2, usual service conditions, as follows:

a. Ambient temperatures within limits specified.
b. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Refer to Division 26 section “General Electrical Requirements”

1.7 DELIVERY, STORAGE, AND HANDLING

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

C. Coordinate delivery of equipment to allow movement into designated space.

D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

E. Handle and prepare switchboard components according to NEMA PB 2.1 and manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

A. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of the switchboards that fail in materials or workmanship within the specified warranty period.

B. Warranty Period: Three years from date of Substantial Completion.

1.9 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 “Seismic Controls for Electrical Systems” and Division 20 Section “Seismic Controls for MEP/F/T Systems”.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

2.2 RATINGS

A. Nominal System Voltage: As indicated on the Drawings.

B. Main-Bus Continuous: Ampacity as indicated on the Drawings.

C. Short-Circuit Current Rating (SCCR):

1. Refer to fault-current and coordination study submittal requirements listed in other parts of this section, in addition to specification section “Overcurrent Protective Device Coordination Study”.
2. Rating value: Rated to interrupt symmetrical short-circuit current available at terminals. Switchgear shall be fully-rated, unless series-rated is indicated on the drawings. SCCR shall not be less than the highest AIC rating of any circuit breaker in switchgear.

2.3 FABRICATION

A. Indoor Enclosures: Steel, NEMA 250, Type 1.

1. Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

B. Outdoor Enclosures: Steel, NEMA 250, Type 3R.

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
2. Structural design and anchorage adequate to resist loads imposed by 125-mph (200-km/h) wind.
3. Louvers equipped with insect and rodent screen and filter; arranged to permit air circulation while excluding insects, rodents, and exterior dust.
4. Hinged front door with padlocking provisions.

5. Interior LED light with switch.
6. Weatherproof duplex receptacle.
7. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.

C. Cubical Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
2. Space-Heater Power Source: Transformer, factory installed in switchboard .

D. Front and rear align all sections.

E. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

F. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

G. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

H. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

I. Barriers: Bus bars shall connect between vertical sections and between compartments. Cable connections are not permitted.

1. Bus isolation barriers shall be arranged to isolate each vertical section. Where indicated, horizontal isolation barriers shall be arranged to isolate adjacent compartments within a vertical section.
2. Insulation and isolation for main bus of main section and main and vertical buses of feeder and tie sections. Barriers between compartments shall extend to the rear of each section.
3. Isolation barriers shall be fabricated in a manner to permit checking of bus-bolt tightness.

J. Buses: Bus bars shall connect between vertical sections and between compartments. Cable connections are not permitted.

1. Bus bars shall connect between vertical sections and between compartments. Cable connections are not permitted.
2. Phase- and Neutral-Bus Material: Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.
3. Main Phase Bus: Size: Ampacity as indicated on drawings, with uniform capacity for entire length of switchboard's main and distribution sections
4. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors.
5. Vertical Section Bus Size: Ampacity equivalent to horizontal bus, with uniform capacity for entire length of vertical section bus.
6. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size required by

UL 891. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

7. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
8. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
9. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.
10. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

    a. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

11. Line-Side Conductor and Feeder Circuit-Breaker Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors unless otherwise indicated on Drawings, suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 section “Low-Voltage Electrical Power Conductors and Cables”. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

K. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

L. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

M. Service Equipment Equipment:

1. Label: Where used as service entrance equipment, provide NRTL label for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.
2. Infrared Windows: Provide with infrared windows in quantities and locations to provide line-of-sight viewing of all cable terminations on the line side of the main overcurrent protective device.

2.4 SURGE PROTECTION DEVICES

A. Provide surge protective devices as required by Division 26 Section “Surge Protective Devices”.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Ratings:

1. Continuous ampere rating: as indicated on drawings.
2. Voltage and frequency rating: same as panelboard.
3. Short-circuit current rating (SCCR): Same as requirements for switchboard.
4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical or compression style as indicated, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
    g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    h. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

C. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time time adjustments.
    c. Ground-fault pickup level, time delay, and I^2t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: as indicated, or as required by control devices per power supply.

D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

    a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
    b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

4. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
5. Service-Rated Switches: Labeled for use as service equipment.
6. 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: 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).

7. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

F. Fuses are specified in Division 26 Section "Fuses."

G. Arc Flash Mitigation

1. Circuit breakers, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset

accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

H. Active arc flash mitigation system connection requirements for service main breaker. Supplier switchboard requirements are as follows:

1. Main breaker must have open, close, 52A contacts.
2. Protection class current transformers..
3. Bus voltage tap on utility side of main.
4. Barrier between main breaker and feeder section.
5. 3-phase open-delta potential transformer.
6. Shunt trip and close coils, 120VAC.

2.6 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Megawatts: Plus or minus 2 percent.
e. Megavars: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

2.7 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.9 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine switchboards before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive switchboards with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.
2. Verify that manufacturer's written instructions for environmental conditions have been established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

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

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and manufacturer’s instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."

D. Equipment Mounting: Install switchboards on concrete bases.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of switchboard unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
2. Anchor switchboards to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Seismic Controls for Electrical Systems."
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to switchboards.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

F. Mount equipment plumb and rigid without distortion of enclosure.

G. Install overcurrent protective devices, surge suppression devices and instrumentation.

H. Install filler plates in unused spaces of panel-mounted sections.

I. Arrange conductors in auxiliary compartments and gutters into groups and bundle and wrap with wire ties.

J. Comply with NECA 1.

K. Install all components needed to connect the active arc flash mitigation system.

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 "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

D. Make all final connections to the active arc flash mitigation system.

3.4 IDENTIFICATION

A. Equipment Nameplates: Label each contiguous main, or entrance, section with equipment nameplate.

B. Device Nameplates: Label each main, feeder and branch circuit device with a nameplate.

C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

D. Diagram and Instructions:

1. Engraved, Laminated Acrylic or Melamine Label. Mount on front of switchboard.

a. Operating Instructions: Printed operating instructions for switchboard, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.
b. System Power One-Line Diagrams: Provide color-coded, large-format one-line diagram showing the new work is to be provided and installed in the associated electrical room. Depict power sources, feeders, distribution components, and major loads.

2. Storage for Maintenance Instructions: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

E. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions throughout periods when equipment environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges and protective relay trip characteristics as specified in Division 26 Section "Power System Studies."

3.8 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control tests and inspections:

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Verify that grounding system at the equipment tested at the specified value or less.
3. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.

E. Infrared Scanning: Perform the following infrared scan tests and inspections and prepare reports:

1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove necessary panels so joints and connections are accessible to portable scanner.
2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
3. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the main incoming section of each service entrance switchboards. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Rebalance loads.
    b. Prepare written request for voltage adjustment by electric utility in accordance with Division 26 section “Provisions for Electric Utility Service”.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.

G. Switchboard will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Distribution panelboards.

B. Lighting and appliance branch-circuit panelboards.

C. Disconnecting and Overcurrent Protective Devices.

D. Surge Protection Devices.

E. Accessory Components and Features.

1.2 DEFINITIONS

A. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.

B. SVR: Suppressed voltage rating.

C. SPD: Surge Protection Device

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies”

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.

    a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Detail enclosure types and details for other than NEMA 250, Type 1.
3. Include general arrangement drawing showing dimensions and weights of each assembled section.
4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
5. Detail short-circuit current rating of panelboard assembly and overcurrent protective devices.
6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
7. Detail utility company's metering provisions with indication of approval by utility company.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include schematic and wiring diagrams for power, signal, and control wiring.
10. Include nameplate legends.
11. Include list of materials.

D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around panelboards where pipe and ducts are prohibited. Show panelboard layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1. For each equipment room, provide dimensioned layout of the electrical equipment within the space, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
2. Dimensioned concrete base, outline of panelboard sections, conduit entries, and ground rod locations; including equipment working clearances and manufacturer required access space.
3. Indicate structural members, light fixtures, sprinkler piping and heads, HVAC equipment, ducts and diffusers, plumbing piping and access fittings. Include maintenance access clearances.
4. Location of structural supports for structure-supported raceways and seismic bracing.
5. Location and clearance of electrical equipment and raceways impacting equipment installation.

E. Qualification Data: For qualified testing agency.

F. Seismic Qualification Data: For panelboard equipment, accessories, and components, from manufacturer.

1. Certificate of compliance.
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.

G. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

H. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

I. Panelboard Schedules: Submit final panelboard directories.

J. Operation and Maintenance Data: For panelboards 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 panelboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. 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.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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. Comply with NEMA PB 1.

G. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

C. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

Commented [RB1]: Alternative:
minus 22 deg F (minus 30 deg C)

This rating would apply to panel boards with fused switches.

Commented [WH2]: Retain paragraph or revise to accommodate unusual service conditions that cannot be eliminated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of equipment to allow movement into designated space.

B. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

C. Handle and prepare panelboards for installation according to NEMA PB 1 and manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

A. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of the panelboards that fail in materials or workmanship within the specified warranty period.

B. Warranty Period: Three years from date of Substantial Completion.

1.9 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section “Seismic Controls for Electrical Systems” and Division 20 Section “Seismic Controls for MEP/F/T Systems”.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers:

1. ABB Inc.
2. Eaton.
3. Schneider Electric.

4. Siemens Energy & Automation, Inc.

B. Enclosures: Flush- or surface-mounted cabinets as noted.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.

2. Hinged Front Cover: Entire front trim hinged to box.
3. Door: Standard door with concealed hinges, within hinged trim cover. Secured with vault-type latch with tumbler lock; keyed alike.
4. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and/or bottom as required.

D. Buses: Three phase, four wire unless otherwise indicated.

1. Phase, and Neutral Buses:

a. Material:

1) Tin-plated aluminum.

a) Hard-drawn copper, 98 percent conductivity,may be substituted if provided at no additional cost.

b. Size: Ampacity as indicated on drawings, with uniform capacity for entire length of panelboard’s sections.

1) Neutral bus: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus

2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

a. Material: Hard-drawn copper, 98 percent conductivity
b. Size: Minimum-size required by UL 67

3. Split Bus: Vertical buses divided horizontally into individual vertical sections.
4. General: Provide any available breaker mounting space with bussing.

E. Line-Side Conductor Connectors (Lugs):

1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”.

2. Material: Same as bus material.
3. Capacity rating: Same as associated bus.
4. Type: Provide mechanical type unless otherwise indicated on Drawings, refer to schedules and one-line diagram.
5. Provide properly sized lugs for all equipment, circuit breakers and other electrical devices to accommodate installed conductors. A larger frame, oversized lugs or non-standard product may be required in some instances.

    a. Pin adapters may be utilized only as allowed by manufacturer and the authority having jurisdiction.

F. Feed-Through Lugs:

1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”.
2. Location: Locate at opposite end of bus from line side lugs or main device.
3. Material: Same as line side conductor connectors.
4. Capacity rating: Same as associated bus.
5. Type: Same as line side conductor connectors.

G. Subfeed lugs (Double Lugs):

1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”.
2. Location: Locate at same end of bus as incoming lugs or main device.
3. Material: Same as line side conductor connectors.
4. Capacity rating: Same as associated bus.
5. Type: Same as line side conductor connectors.

H. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

I. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

J. Short-Circuit Current Rating (SCCR):

1. Refer to fault-current and coordination study submittal requirements listed in other parts of this section, in addition to specification section “Overcurrent Protective Device Coordination Study”.
2. Rating value: Rated to withstand symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings. SCCR shall not be less than the highest AIC rating of any circuit breaker in panelboard.

2.2 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

C. Mains: As indicated on drawings.

D. Branch Overcurrent Protective Devices:

1. Connection to bus:

a. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
b. 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.

2. Type: Provide types as indicated on drawings and as defined below.

E. Device Ratings:

1. Continuous ampere rating: as indicated on drawings.
2. Voltage and frequency rating: same as panelboard.
3. Short-circuit current rating (SCCR): Same as requirements for panelboard.
4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: Circuit breaker type: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: As indicated on drawings.

C. Branch Overcurrent Protective Devices:

1. Connection to bus: Plug-in circuit breakers, replaceable without disturbing adjacent units.
2. Type: Provide types as indicated on drawings and as defined below.

D. Device Ratings:

1. Continuous ampere rating: as indicated on drawings.
2. Voltage and frequency rating: same as panelboard.
3. Short-circuit current rating (SCCR): Same as requirements for panelboard.
4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical type unless otherwise indicated on Drawings, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

        1) Mounting: Integral

    e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
    f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
    j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
    k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
    l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

    1. Fuses are specified in Division 26 Section "Fuses."

C. Arc Flash Mitigatio

    1. Circuit breakers, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
    2. Documentation shall be provided in accordance with the NEC for location of overcurrent device and method of clearing time reduction.

2.5 SURGE PROTECTION DEVICES

A. Provide surge protective devices as required by Division 26 Section “Surge Protective Devices”.

B. Panelboards requiring SPD and the location of the devices shall be as indicated on the Drawings.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

2.7 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive panelboards with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.
2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1 and manufacturer’s instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."

D. Wall-Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panelboards not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

E. Floor-Mounted Panelboards: Install panelboards on concrete bases.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of panelboards unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
2. Anchor panelboards to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Seismic Controls for Electrical Systems."
3. 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.
4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to panelboards.
7. Attach panelboards to the vertical finished or structural surface behind the panelboards.

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

G. Mount top of trim 72 inches (1788 mm)above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Install overcurrent protective devices and controllers not already factory installed.

J. Install filler plates in unused spaces.

K. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

1. Empty conduits shall be provided with pull strings.
2. Cap and label empty conduits for future use.

L. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

M. Comply with NECA 1.

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 "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

A. Equipment Nameplates: Label each contiguous main, or entrance section with equipment nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

D. Diagram and Instructions:

1. Engraved, Laminated Acrylic or Melamine Label . Mount on front of panelboard.

a. Operating Instructions: Printed operating instructions for panelboard, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.

E. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.

1. Exception: Do not install NFPA 70 working clearance requirements on flush panelboards and similar equipment in finished spaces.

F. Panel Directories

1. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
2. Note the date the directory was created/updated.
3. Create directory after loads have been balanced to reflect actual as-built conditions.
4. Circuit descriptions shall be per code and shall be distinguishable from all others.
5. Replace existing directories with revised type written directories indicating changes.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Power System Studies."

3.8 FIELD QUALITY CONTROL

A. 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.

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Verify that grounding system at the equipment tested at the specified value or less.
3. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
4. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.

E. Infrared Scanning: Perform the following infrared scan tests and inspections and prepare reports:

1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
3. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

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SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electricity meters.

1.2 DEFINITIONS

A. KY or KYZ Pulse: Term used by metering industry to describe method of measuring consumption of electricity (kWh) that is based on relay opening and closing in response to rotation of disk in meter. Electronic meters generate pulses electronically.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of meter.

B. Shop Drawings: For electricity-metering equipment.

1. Include diagrams for power, signal, and control wiring.
2. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Installation of metering equipment.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreement.

B. Warranty documentation.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Comply with UL 916.

2.2 ELECTRICITY METERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

1. Available Manufacturers:

a. Electro Industries
b. ABB, Quad Logic
c. Schneider Electric, Square D

B. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

C. General Requirements for Meters:

1. Comply with NEMA ANSI C12.1 and NEMA ANSI C12.20, **0.5** accuracy class or better.
2. Ambient Temperature: Minus 22 deg F to plus 158 deg F.
3. Humidity: Zero to 95 percent, noncondensing.
4. Capacities and Characteristics:

a. Circuit: 120/240 V(ac), 100 A.
b. Measure: kWh, onboard LED display.
c. Remote-Reading Options: None.

5. Billing Meters Accuracy: **0.5** percent of reading, complying with NEMA ANSI C12.20.
6. Enclosure: Supplied by meter manufacturer, UL 50E, **Type 3R** minimum, with provisions for locking or sealing.
7. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
8. Onboard Nonvolatile Data Storage: kWh, until reset.
9. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

a. Type: **Split** core, complying with recommendation of meter manufacturer.

D. kWh Meter: Electronic **three-phase** meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter must be designed for use on circuits with voltage rating and phase configuration indicated for its application.

2. Display:

    a. LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in nonvolatile memory, until reset.

E. kWhd Meter: Electronic **three-phase** meters, measuring electricity use and demand. Demand must be integrated over **15-minute** interval.

1. Voltage and Phase Configuration: Meter must be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating the following:

    a. Accumulative kWh.
    b. Current time and date.
    c. Current demand.
    d. Historic peak demand.
    e. Time and date of historic peak demand.

3. Retain accumulated kWh and historic peak demand in nonvolatile memory, until reset.

F. KY and KYZ Pulse Totalizer:

1. Pulse Totalizer: Instrument for demand and billing applications where one or more utility revenue meters stream KY or KYZ energy pulses. Instrument must totalize kWh accumulated over user-selected period and must log maximum and minimum kWhd for that period. Record each period with date/time stamp. Time period must be user selected from one to 60 minutes.

    a. Pulse Input: Two, individually programmable, KYZ Form C (three-wire) contact pulse channels. Pulse interval, pulse rate, and minimum pulse width must be field adjustable, set for pulse stream provided by utility revenue meter.
    b. Data Totalizing Capacity of Each Channel: Not less than 149 days at 15-minute intervals.
    c. Instrument Power: User selectable, 120 V(ac) and 277 V(ac).
    d. Clock: Line frequency.

G. Remote Reading Options:

1. Pulse Output: **KYZ**, complete with optical sensor and interface devices.
2. TCP/IP adapter.

H. The meter shall have data logging capability of up to 32 MB memory. The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created.

I. Data Transmission Cable: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Install arc-flash labels as required by NFPA 70.

C. Special Techniques:

1. Wiring Methods:

a. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533.13 "Conduits for Electrical Systems."
b. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
c. Minimum conduit size is metric designator 16 (trade size 1/2).
d. Disaggregate loads by panel, such that each panel serves only one major system type (i.e. HVAC, Lighting, MHE, Refrigeration, Plug load).
e. Install submeters for each major system type (HVAC, Lighting, MHE, Refrigeration, Plug load).

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Equipment Identification Labels: Self-adhesive labels with clear protective overlay.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Equipment and Software Setup:

a. Set meter date and time clock.
b. Test, calibrate, and connect pulse metering system.
c. Set and verify billing demand interval for demand meters.
d. Report settings and calibration results.
e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.

2. Connect load of known power rating, **1.5 kW** minimum, to circuit supplied by metered feeder.
3. Turn off circuits supplied by metered feeder and secure them in off condition.
4. Run test load continuously for eight hours minimum, or longer, to obtain measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
6. Connect submeters to report through Niagara BMS.

B. Nonconforming Work:

1. Electricity metering will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports.

D. Manufacturer Services:

1. Engage factory-authorized service representative to **support** field tests and inspections.

3.4 PROTECTION

A. After installation, protect metering equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262713

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles: Single, duplex, twist-lock, and ground-fault circuit interrupters (GFCI).
2. AC Wall Switches: Single- and double-pole, three- and four-way, maintained and momentary, pilot light and lighted toggle.
3. Device Wall Plates.

1.2 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. PIR: Passive Infrared.

C. RFI: Radio Frequency Interference

D. SPD: Surge Protective Device

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.

B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
2. Marked for intended use.

D. Comply with NFPA 70.

1.4 COORDINATION

A. Receptacles for Equipment Furnished by Owner or Under Other Divisions or Contracts: Match plug configurations.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, special purpose receptacles, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

2.2 MANUFACTURERS

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

1. Receptacles and Switches:

a. Eaton.
b. Hubbell Incorporated.
c. Legrand.
d. Leviton.

B. In other Part 2 articles below, where lists of manufacturers and device catalog numbers are included, the following additional requirements apply to product selection:

1. Product manufacturer and model numbers listed are to establish the quality of the wiring devices: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers listed in individual articles below, in addition to those listed in Paragraph “Manufacturers” above.
2. Coordinate the proper suffixes in order to provide the correct color as specified below.

2.3 FINISHES

A. Color:

1. Wiring devices connected to normal power systems: White, unless otherwise indicated or required by NFPA 70. Cover plates: The same as the wiring device.

B. Manufacturer's model numbers listed are to establish the quality of the wiring devices. Coordinate the proper suffixes in order to provide the correct color as specified above.

2.4 CONVENIENCE RECEPTACLES:

A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A.

B. Duplex convenience receptacles: Heavy Duty Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
Basis of Design: Legrand 5362 duplex; similar for simplex.

C. Twist-Locking type receptacles: NEMA L5-20R, 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, self-grounding.
Basis of Design: Legrand L520-R.

2.5 GFCI RECEPTACLES

A. Ground fault circuit interrupter type receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.
Basis of Design: Legrand 2097

B. Ground fault circuit interrupter type weather-resistant receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA

within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

Basis of Design: Legrand 2097TRWR

C. Ground fault circuit interrupter with Blank Face: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

Basis of Design: Legrand 2085.

2.6 SWITCHES

A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide switches equivalent to those specified for 20A, but rated for 15A.

B. Switches: Heavy Duty Specification grade, rated for 120/277V, 20A, back and side wired, and UL listed and labeled.

Basis of Design: Legrand:

1 pole	PS20AC1
2 pole	PS20AC2
3-way	PS20AC3
4-way	PS20AC4

2.7 REMOTE GROUND FAULT CIRCUIT INTERRUPTER (GFCI) DEVICES

A. Manufacturers:

1. Hubbell
2. Littlefuse
3. North Shore Safety

B. UL 943 Class A Ground Fault Circuit Interrupter (GFCI) device in NEMA 4X wet location enclosure, voltage, phase, and current rating as shown on drawings. UL 943. Device shall have power and fault status indication lights and manual test and reset buttons on exterior of enclosure. Device shall allow for reset as follows:

1. Automatic reset: Allows power downstream as long as power is available and will allow power downstream upon restoration of lost power. Requires reset button be pressed if unit trips due to fault condition.

2.8 COVER PLATES

A. Damp Location Weatherproof Receptacle Cover Plates: UL-listed Wet Location (cover closed, not in use); die-cast, gasketed (factory-installed) self-closing covers, for vertical mounting as indicated:

Basis of Design: Legrand 4512 vertical.

A. Wet Location Weatherproof Receptacle Cover Plates (Outlet Box Hood): NEMA 3R weather resistant recessed or flush mount, die cast aluminum lockable cover. Configure cover for horizontal mounting of receptacle or as indicated otherwise. Back box must be suitable for conduit connections. Coordinate back box with wall depth.

Basis of Design: Leviton IUM1H-GY.

B. Damp and Wet Location Weatherproof switch cover plates: Fabricated of cast aluminum or cast zinc, sealed water-tight and UL listed for wet locations.
Basis of Design: Appleton FSK.

C. Other locations: Single and combination types to match corresponding wiring devices and manufacturer of wiring devices specified herein.

1. Plate securing screws: Metal with head color to match finish plate.
2. Material for Finished Spaces: Smooth plastic, minimum 0.10-inch thick. Refer to “Finishes” above for color.
3. Material for Unfinished Spaces and surface mounted wiring devices: Galvanized steel.
4. Masonry walls and oversized wall openings: Jumbo size plates with same material as indicated above.

PART 3 - EXECUTION

3.1 GENERAL

A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the Contract Administrator.

B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.

C. Provide twist-locking type receptacles or other special type receptacles where indicated on the Drawings.

3.2 EXAMINATION

A. Verify existing conditions prior to beginning work.

B. Verify that outlet boxes are installed at proper height and are flush with the finished surface.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.3 PREPARATION

A. If required, provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from in and around outlet boxes.

3.4 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.

C. Connect wiring devices by wrapping conductors around screw terminals. 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.

D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box. Exception: Do not bond grounding terminals of isolated ground receptacles to the outlet box.

E. Install devices shown on wood trim, cases or other fixtures symmetrically and, where necessary, set with the long dimensions of the plate horizontal, or ganged in tandem.

F. Unless dimensioned otherwise, install wiring devices a minimum of 24 inches from the closest edge of any sink.

G. Install switches with OFF position down.

H. Install cover plates on all switches, receptacles, and blank outlets.

I. Locate wiring devices so that the cover plate does not have to be cut to be installed.

J. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.

K. Install cover plates after the wall has been finished (painted, wall paper, etc).

L. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

M. Provide ground fault circuit interruption capability for all 120V receptacles 50A or less and all 208/240V receptacles 100A or less in code required locations. Locations include, but are not limited to: bathrooms, kitchens/food prep areas, exterior locations and within 6’ or sinks. Interruption capability can be achieved via a GFCI circuit breaker or a GFCI receptacle.

N. Install wiring devices shown back-to-back on a common wall offset a minimum of 12” horizontally to reduce sound transmission between rooms.

3.5 MOUNTING HEIGHTS

A. Coordinate locations of outlet boxes provided under Division 26 Section “Common Work Results for Electrical”.

B. Unless noted otherwise, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.

1. Receptacles:

a. General:

1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.
2) Where Installed horizontally, install neutral slot mounted at the top.

b. Above counters:

1) Mount vertically.

c. Mechanical and electrical equipment rooms and janitors closets:

1) Mount vertically.

d. Weatherproof exterior receptacles:

1) Mount horizontally.

e. GFCI receptacles: Same as general receptacles.
f. Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.

2. Switches:

a. Above counters: Same as for receptacles.
b. Concrete Block Walls: Dimension may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom of boxes are at block joints.
c. Walls with wainscoting: 6 inches minimum above wainscoting, but not exceeding 48 inches above finished floor.

3. Telephone/Data Outlet Boxes:

a. General: Match mounting height of adjacent wiring device listed above.

3.6 IDENTIFICATION

A. Label all devices fed down stream of GFCI protected receptacles as “GFCI PROTECTED”.

B. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served, using:

a. Adhesive Film Label with Clear Protective Overlay, but with letter/number height of 1/4 inch, on face of plate, for exterior and damp/wet locations.

3.7 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.

D. Test all wiring devices for electrical continuity and proper polarity of connections.

E. Test each GFCI receptacle device for proper operation.

F. Correct wiring devices incorrectly installed.

G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.8 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

3.9 CLEANING

A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION 262726

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SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in:

a. Control circuits
b. Enclosed switches
c. Switchboards
d. Enclosed controllers

2. Spare-fuse cabinets.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Fault -Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Power System Studies.”

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper if available.
5. Coordination charts and tables and related data.

B. Operation and Maintenance Data: For fuses 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. All items requested under “Product Data”.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. 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.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

B. Coordinate location of and access to spare fuse cabinet(s) with final electrical equipment layouts within electrical equipment rooms.

1.7 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.

C. Provide fuses of the same type, rating, and manufacturer within the same switch.

D. Selectivity: Where selectivity is required by the Documents, furnish products as required to achieve selective coordination.

2.2 MANUFACTURERS

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

1. ABB Ltd.
2. Eaton Corporation Plc
3. Mersen Electrical Power
4. Littelfuse, Inc.
5. Schneider Electric SE
6. Siemens AG

2.3 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.4 ACCESSORIES

A. Provide the following accessories where indicated or where required to complete installation:

1. Fuseholders: Compatible with indicated fuses.
2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.
3. Plug-Fuse Adapters: For using Type S, rejection-base plug fuses in Edison-base fuseholers or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install in accordance with manufacturer's instructions.

C. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

D. Install spare-fuse cabinet(s).

3.3 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance:

a. Greater than 600A:

1) Class L, time delay

b. 600A or less:

1) Class RK1, time delay

2. Feeders:

a. Greater than 600A:

1) Class L, time delay

b. 600A or less:

1) Class RK1, time delay

3. Motor Branch Circuits:

a. Class RK1 time delay

4. Other Branch Circuits:

a. Class RK1, time delay

5. Control Circuits:

a. Class CC fast acting

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Shunt trip switches.
4. Molded-case circuit breakers (MCCBs).
5. Molded-case switches.
6. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of enclosed switches, circuit breakers and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Overcurrent Protective Device Coordination Study”.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. 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, accessories, and finishes.

C. Shop Drawings: For enclosed switches and circuit breakers.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.

    a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Detail enclosure types and details for other than NEMA 250, Type 1.
3. Include general arrangement drawing showing dimensions and weights of each assembled section.
4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
5. Detail short-circuit current rating of enclosed switch or circuit breaker assembly and overcurrent protective devices.
6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
7. Include schematic and wiring diagrams for power, signal, and control wiring.
8. Include nameplate legends.
9. Include list of materials.

D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Qualification Data: For qualified testing agency.

G. Manufacturer's field service report.

H. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.

I. 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 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

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.

D. 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.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not deliver or install enclosed switches and circuit breakers until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
    b. Altitude: Not exceeding 6600 feet (2010 m).

C. Interruption of Existing Electric Service: Refer to Division 26 section “General Electrical Requirements”

1.7 DELIVERY, STORAGE, AND HANDLING

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

B. Deliver enclosed switches and circuit breakers in sections or lengths that can be moved past obstructions in delivery path.

C. Coordinate delivery of equipment to allow movement into designated space.

D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.

E. Handle and prepare enclosed switches and circuit breakers components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

A. Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components and/or products of the enclosed switches and circuit breakers that fail in materials or workmanship within the specified warranty period.

B. Warranty Period: Three years from date of Substantial Completion.

1.9 SEISMIC REQUIREMENTS

A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section “Seismic Controls for Electrical Systems” and Division 20 Section “Seismic Controls for MEP/F/T Systems”.

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. Fuses: Refer to Division 26 section “Fuses” for spare fuse requirements. At a minimum, include spares for the following:

a. Potential transformer fuses.
b. Control power fuses.
c. Fuses for fusible devices.

2. Indicating Lights: Four of each type installed.
3. Primary Switch Contact Lubricant: One container.
4. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Compression type, suitable for number, size, and conductor material.

2.3 SHUNT TRIP SWITCHES

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

1. Eaton.
2. Littelfuse, Inc.
3. Mersen
4. Siemens Energy & Automation, Inc.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.

C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.

E. Accessories:

1. Oiltight key switch for key-to-test function.
2. Oiltight red ON pilot light.
3. Isolated neutral lug; 100 percent rating.
4. Form C alarm contacts that change state when switch is tripped.

2.4 MOLDED-CASE CIRCUIT BREAKERS

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

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. 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.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings,

push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring and Control."
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.
12. Accessory Control Power Voltage: Integrally mounted, self-powered 120-V ac.

2.5 MOLDED-CASE SWITCHES

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

1. ABB Inc.
2. Eaton.
3. Schneider Electric.
4. Siemens Energy & Automation, Inc.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
7. Alarm Switch: One NO contact that operates only when switch has tripped.
8. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
10. Electrical Operator: Provide remote control for on, off, and reset operations.
11. Accessory Control Power Voltage: Integrally mounted, self-powered 120-V ac.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

2.7 IDENTIFICATION

A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine enclosed switches and circuit breakers before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive enclosed switches and circuit breakers with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.
2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

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

3.2 INSTALLATION

A. Install enclosed switches and circuit breakers and accessories in accordance with manufacturer’s instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."

D. Wall-Mounted Switches and Circuit Breakers: Install enclosed switches and circuit breakers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For enclosed switches and circuit

breakers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

E. Floor-Mounted Switches and Circuit Breakers: Install enclosed switches and circuit breakers on concrete bases.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of enclosed switches and circuit breakers unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
2. Anchor enclosed switches and circuit breakers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Seismic Controls for Electrical Systems."
3. 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.
4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to enclosed switches and circuit breakers.

F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

G. Mount equipment plumb and rigid without distortion of enclosure.

H. Install fuses in fusible devices.

I. Comply with NECA 1.

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 "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

A. Equipment Nameplates: Label each section with equipment nameplate.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

C. Diagram and Instructions:

1. Engraved, Laminated Acrylic or Melamine Label. Mount on front of equipment.

a. Operating Instructions: Printed operating instructions for switches and circuit breakers, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.

D. Warning Labels: Label equipment with a warning label in accordance with NFPA 70 and NFPA 70E.

1. Exception: Do not install NFPA 70 working clearance requirements on enclosed switches and circuit breakers in finished spaces.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges and protective relay trip characteristics as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.8 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control 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.

B. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Verify that grounding system at the equipment tested at the specified value or less.
3. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.

2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
5. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.

E. Infrared Scanning: Perform the following infrared scan tests and inspections and prepare reports:

1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
3. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the main incoming section of each service entrance equipment. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Rebalance loads.
    b. Prepare written request for voltage adjustment by electric utility in accordance with Division 26 section “Provisions for Electric Utility Service”.

G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for UL 96A Master Labeled lightning protection system consisting of air terminals on roofs, roof mounted mechanical equipment, stacks, bonding of structure and miscellaneous metal objects; Grounding electrodes; and interconnecting conductors.

B. System Design: Contractor shall perform all calculations and develop all plan and detail drawings required, in conjunction with these specifications, for installation of a complete and fully functional lightning protection system.

1.2 CODES, REFERENCES AND STANDARDS

A. Applicable Codes and Standards

1. NFPA 70 – National Electrical Code
2. UL 96 – Lightning Protection Components
3. UL 96A – Installation requirements for Lightning Protection Systems
4. NFPA 780 – Lightning Protection Systems
5. LPI 175 – Standard of Practice for the Design – Installation – Inspection of Lightning Protection Systems

1.3 DEFINITIONS

A. The following definitions apply to terms used in this section:

1. Air Terminal: A strike termination device that is a receptor for attachment of flashes to the lightning protection system and is UL listed for that purpose.
2. Bonding: An electrical connection between an electrically conductive object and a component of a lightning protection system that is intended to significantly reduce potential differences created by lightning currents.
3. Class I Materials: Lightning conductors, air terminals, ground terminals, and associated fittings required by NFPA 780 for protection of structures not exceeding 75 feet (23 meters) in height.
4. Bonding conductor: A conductor intended to be used for equalization between grounded metal bodies and a lightning protection system.
5. Main conductor: A conductor intended to be used to carry lightning currents between strike termination devices (air terminals) and ground terminals.
6. UL: Underwriters Laboratories, Inc.

1.4 SUBMITTALS

A. Product Data: Submit product data showing dimensions and materials of each component including listing in accordance with UL 96A.

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system showing layout of air terminals grounding electrodes, and bonding connections, along with details of the components to be used in the installation.

2. Include indications for use of raceway, conductor sizes, roof and/or floor penetrations, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
3. Layout and installation drawings shall be fully coordinated with other trades. Failure of the lightning protection contractor to perform this coordination shall not relieve said contractor from properly completing the work.

C. Qualification Data: For qualified manufacturer. Include data on listing or certification by UL.

1. Manufacturer: A company specializing in lightning protection equipment with minimum 3 years documented experience and membership in good standing with the Lightning Protection Institute.

D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

E. Field quality-control reports.

F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Ground loop conductor.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Certified by UL, trained and approved for installation of units required for this Project.
2. The contractor shall be recognized as being regularly engaged in the design and installation of lightning protection systems with a minimum of 3 years documented experience.
3. Include documentation of certification and experience with all submitted bids.

B. System Certificate:

1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. All materials used in the installation shall be new and shall comply in weight, size, and composition with UL 96 and NFPA 780. Materials shall be labeled or listed by UL for use on lightning protection systems.

B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum or copper unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following

a. East Coast Lightning Equipment Inc.
b. ERICO International Corporation.
c. Harger.
d. Heary Bros. Lightning Protection Co. Inc.
e. Independent Protection Co.
f. Preferred Lightning Protection.
g. Robbins Lightning, Inc.
h. Thompson Lightning Protection, Inc.
i. VFC

2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.

C. Main and Bonding Conductors: Copper or Aluminum and Class I.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

2.2 SURGE PROECTIVE DEVICES

A. Surge Protective Devices SPD’s required to meet UL 96A for UL Master Labeling shall be as specified in Division 26 Section “Surge Protective Devices”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Install lightning protection components and systems according to UL 96A and NFPA 780.

C. Install conductors with two direct paths from air terminals to ground connections. Avoid sharp bends. Follow the manufacturer’s written installation instructions.

D. Conceal the following conductors:

1. System conductors.

2. Down conductors.
3. Interior conductors.
4. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

G. Air Terminals on Mechanical Equipment: Air terminals on mechanical equipment shall be mounted such that maintenance operations can be performed without relocation of the air terminal or interconnecting conductors.

H. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

I. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

1. Bury ground ring not less than 24 inches (600 mm) from building foundation.
2. Bond ground terminals to the ground loop.
3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.
4. Interconnect lightning protection ground loop with the building electrical service grounding electrode system at one place only.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION 264113

SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes field-mounted Surge Protective Devices (SPDs) for low-voltage (120 to 600 V) power distribution and control equipment, including:

1. Surge Protection Devices at Service Entrance Equipment
2. Surge Protection Devices at Distribution Equipment
3. Surge Protection Devices at Branch Panelboards

1.2 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. VPR: Voltage Protection Rating. The average of measured limiting voltage before and after Nominal Discharge Testing (In),) rounded up to one of UL's VPR categories (Table 63.1 of ANSI/UL 1449 Third Edition) such as 330 volt, 400 volt, 500 volt, etc. VPR is posted on each device UL label.

C. In or In or Inominal: Nominal Discharge Current. Peak value of surge current, selected by the manufacturer, through the SPD having current wave shape of 8/20 microseconds where the SPD remains functional after 15 surges. In is posted on the device UL label.

D. SPD: Surge Protective Device. Previously Transient Voltage Surge Suppressor (TVSS), a broad class of protective devices, installed parallel with the distribution panel or service disconnect, meant to protect downstream electrical distribution equipment from the effects of high voltage surges on the line.

E. MCOV: Maximum Continuous Operating Voltage. The maximum continuous operating voltage rating of a Metal Oxide Varistor (MOV) that can be applied without the MOV being damaged and/or destroyed by thermal runaway. MCOV is posted on the device UL label.

F. SCCR: Short Circuit Current Rating. The maximum current rating the SPD can sustain without being damaged and/or destroyed. SCCR is posted on the device UL label.

G. SPD Type:

1. TYPE 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device. Type 1 devices are required for Master Certification of Lightning Protection System installations under UL 96A.
2. TYPE 2: Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch circuit panel.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of SPDs and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access.

B. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section “Overcurrent Protective Device Coordination Study”.

C. Do not energize or connect any electrical or low voltage equipment to their sources until SPDs are installed and connected.

D. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”.

B. Product Data: For each SPD type, accessory, component and enclosure indicated. Include dimensions and Manufacturer’s technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes. Tabulate model number, SPD type, system voltage, phases, modes of protection, MCOV, VPR, and I_n.

C. Shop Drawings: For SPDs.

1. Detail enclosure types and details.
2. Include general arrangement drawing showing dimensions and weights of each assembled device.
3. Include installation and mounting details for SPDs internal to equipment.
4. Detail bus connection configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus.
5. Detail short-circuit current rating of SPD assembly and overcurrent protective devices.
6. Include schematic and wiring diagrams for power, signal, and control wiring.
7. Include nameplate legends.
8. Include list of materials.

D. Qualification Data: For qualified testing agency.

E. Product Certificates: For SPD devices, from manufacturer.

F. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Project Record Documents: Record actual installed equipment and circuiting arrangements.

H. Operation and Maintenance Data: For SPDs 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 SPDs and all installed components.
2. Manufacturer's written instructions for testing and adjusting SPDs.
3. Time-current curves for each type of overcurrent protective device.
4. Features and operating sequences, both automatic and manual.
5. Video recording of operation training and demonstration.

I. Follow-up service reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member Company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

C. Source Limitations: Obtain SPDs of each type and associated components and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

E. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

F. Comply with NEMA LS 1.

G. Comply with ANSI/ UL 1449 Third Edition.

H. Comply with NFPA 70.

I. The SPD shall be compliant with the restrictions of the Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 PROJECT CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

B. Environmental Limitations:

1. Do not install SPDs until spaces are enclosed and weathertight. Equipment shall be protected from any remaining wet work in the space and work above equipment. Provide temporary HVAC system for maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
b. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
c. Humidity: 0 to 85 percent, noncondensing.
d. Altitude: Less than 20,000 feet (6090 m) above sea level.

C. Interruption of Existing Electrical Service: Refer to Division 26, Section “General Electrical Requirements”.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish.

B. Handle and prepare SPD components according to manufacturer's written instructions.

1.8 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

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

1.9 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. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manufacturers:

1. ABB USA.
2. Eaton.
3. Intermatic, Inc.
4. LEA International.
5. Leviton Mfg. Company Inc.
6. Siemens.
7. Schneider Electric.
8. Surge Suppression Incorporated.
9. Vertiv.

B. Surge Protective Device Ratings: Device type ratings shall be:

1. Type 1 - Service entrances
2. Type 2 - Service entrance equipment or distribution equipment

C. Nominal System Voltage: Match the system voltage to which the SPD is connected, as indicated on the drawings.

D. Maximum Continuous Operating Voltage: Not less than 125 percent of nominal system voltage for 240V or less power systems, and not less than 115 percent of nominal system voltage for 600V and 480V power systems.

E. Comply with ANSI/UL 1449.

F. SPDs for Lightning Protection: For Lightning Protection Systems specified or otherwise required to be “Master Labeled” per UL 96A utilize Type 1 (20kA rated I_n) SPDs.

2.2 SURGE PROTECTION DEVICES AT SERVICE ENTRANCE EQUIPMENT

A. Surge Protection Devices: Externally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits; with individually fused metal-oxide varistors,
5. Redundant replaceable modules.
6. EMI filtering: Minimum 45dB at 100kHz for L-N Modes.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
11. Four-digit transient-event counter set to totalize transient surges.

B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 1 SPD’s shall be tested and labeled at 20kA per mode.
2. Type 2 SPD’s shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 320 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 240/120 V circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1400 from high leg
Line to Ground	1000	1000, 1400 from high leg
Neutral to Ground	700	700

3. Protection mode VPR for 3-phase, 3-wire, delta circuits shall be as follows:

	240V	240V (Delta)	480V	600V
Line to Line	1000	1500	2000	2500
Line to Ground	800		2000	2500

2.3 SURGE PROTECTION DEVICES AT DISTRIBUTION EQUIPMENT

A. Surge Protection Devices: Externally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits; with individually fused metal-oxide varistors,
5. Redundant replaceable modules.
6. EMI filtering: Minimum 45dB at 100kHz for L-N Modes.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
11. Four-digit transient-event counter set to totalize transient surges.

B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 1 SPD’s shall be tested and labeled at 20kA per mode.
2. Type 2 SPD’s shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits, 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 1-phase, 3-wire circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1500 from high leg
Line to Ground	1000	1000
Neutral to Ground	700	700

3. Protection mode VPR for 3-phase, 3-wire, delta circuits shall be as follows:

	240V	240V (Delta)	480V	600V
Line to Line	1000	1500	2000	2500
Line to Ground	800		1500	2500

2.4 SURGE PROTECTION DEVICES AT BRANCH PANELBOARDS

A. Surge Protection Device: Externally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits; with individually fused metal-oxide varistors,
5. Redundant replaceable modules.
6. EMI filtering: Minimum 45dB at 100kHz for L-N Modes.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
11. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
12. Four-digit, transient-event counter set to totalize transient surges.

B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.

1. Type 2 SPD’s shall be tested and labeled at 20kA per mode.

C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits, 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 1-phase, 3-wire circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1500 from high leg
Line to Ground	1000	1000
Neutral to Ground	700	700

3. Protection mode VPR for 3-phase, 3-wire, delta circuits shall be as follows:

	240V	240V (Delta)	480V	600V
Line to Line	1000	1500	2000	2500
Line to Ground	800		1500	2500

2.5 ENCLOSURES

A. All SPD Units shall be fully enclosed unless otherwise noted. Provide enclosures suitable for the locations indicated and as described below:

1. Indoor Enclosures:

a. NEMA 250 Type 1 constructed of a polymer or steel material

2. Outdoor Enclosures:

a. NEMA 250 Type 3R constructed of steel material and with a gasket to exclude dirt, windblown dust, and water (rain, sleet, and snow) from entering the enclosure when shut.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surge suppression devices before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.

B. Examine areas, surfaces, substrates, and elements to receive SPDs with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that field measurements are as indicated.
2. Verify that manufacturer's written instructions for environmental conditions have been established in spaces where equipment will be installed, before installation begins.

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

3.2 INSTALLATION

A. Install SPDs and accessories in accordance with manufacturer’s instructions.

B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access.

C. Wall-Mounted Surge Protective Devices: Install SPDs on walls adjacent to equipment served, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For SPDs not at walls, mount to similar support structure for equipment served by device. Comply with Division 26 Section "Hangers and Supports for Electrical Systems."

D. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.

E. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.

F. Mount equipment plumb and rigid without distortion of enclosure.

G. Install fuses in fusible devices.

H. Comply with NECA 1.

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 "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

A. Nameplates: Label external device enclosures with equipment served.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

C. Warning Labels: Label device with a warning label in accordance with NFPA 70 and NFPA 70E.

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 FIELD QUALITY CONTROL

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

B. Acceptance Testing Preparation:

1. After installing SPD but before equipment is energized, test for compliance with requirements.
2. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

3. Complete startup checks according to manufacturer's written instructions.
4. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. SPD device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 264313

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Included in the work of this section are labor, material, and appurtenances required to complete the work of this Section as specified herein, including, but not limited to:

1. Interior light fixtures, lamps, LEDs, reflectors, lenses or faceplates, transformers, drivers and power supplies (includes exterior light fixtures normally installed on exterior surfaces of buildings).
2. Exit signs.
3. Light fixture supports.
4. Coordination.
5. Quality assurances.
6. Specific requirements.

1.2 PERFORMANCE SPECIFICATIONS FOR SUSTAINABILITY GOALS

A. LED Lighting Fixtures

1. All lighting fixtures must be high performance LED fixtures.

a. Office areas: 0.71W/SF or better, 30FC minimum @ 36” AFF.
b. Warehouse: 0.26W/SF or better, 30FC minimum @ 36” AFF.

1.3 SUBMITTALS

A. General:

1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.
2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
3. Prepare portfolios from manufacturer's standard specification sheets, and include the fixture tag indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.
4. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
5. Modifications to fixtures shall be in accordance with Architect’s comments.

B. Product Data: For each type of light fixture, collated and bound in sets, and arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Summary page with the following for each light fixture type

a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
b. Light fixture driver or auxiliary device manufacturer, number and type.

2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.

    a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, fixture efficacy and/or efficiency, and verification of indicated parameters.
    b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.

        1) Include MacAdam ellipse step information for:

            a) All interior light fixtures
            b) Exterior luminaires installed on exterior building surfaces specified with 80 CRI or greater.

3. Light fixture mounting details, including non-standard outlet boxes.
4. Construction of light fixture housing and door (if applicable).
5. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.
6. Light fixture finish and color (if applicable).
7. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.

    a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.

8. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the light fixture as applied in this Project.

    a. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

9. Emergency driver cut sheet: Descriptive cut sheets providing physical description of emergency ballasts for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.

C. Shop Drawings: Show details of non-standard or custom light fixtures. Indicate dimensions, finish color, including, but not limited to, custom color, weights, methods of field assembly, components, features, accessories, and modifications. Scaled documents shall be provided for custom fixtures.

D. Submittal Schedule

1. Within 30 days of Division 26 contractor award, shop drawings covering all light fixtures within this section shall be forwarded to architect to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.
2. Within 15 days of “approved” and “approved as noted” shop drawings, contractor shall forward to Architect a guaranteed ship date for each specified fixture.

3. Within 15 days after contractor's receipt of "reject and resubmit" or "not approved" shop drawings, contractor shall provide Architect with resubmitted shop drawings for only those fixtures deemed unacceptable.
4. Contractor is responsible to call to the attention of the Architect any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures or as otherwise affecting Section 1.4.D of this specification.

E. Control Wiring

F. Coordination Drawings: Refer to architectural reflected ceiling plans or details for exact location of light fixtures; engineering documents shall not be referenced for exact fixture positions. Contractor shall check and verify dimensions and details on drawings before proceeding with the work. If any question arises about the true meaning of drawings, refer the matter to the Architect, whose decision is final. In no case proceed with work with any uncertainty. Architectural documents shall show and coordinate with assistance from installers of items involved:

1. Light fixtures.
2. Suspended ceiling components.
3. Structural members to which suspension systems for light fixtures will be attached.
4. Other items in finished ceiling including the following:
5. Air outlets and inlets.
6. Speakers.
7. Sprinklers.
8. Smoke and fire detectors.
9. Occupancy sensors.
10. Access panels.
11. Perimeter moldings.

G. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

H. Qualification Data: For agencies providing photometric data for light fixtures.

I. Field quality-control test reports.

J. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation and maintenance manuals.

K. Warranties: Special warranties specified in this Section.

1.4 DEFINITIONS

A. CCT: Correlated color temperature

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. EISA: Energy Independence and Security Act of 2007.

E. FC: Foot-candles.

F. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs

G. LED: Light Emitting Diode

H. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.

I. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.

J. LER: Light fixture (Luminaire) efficiency rating.

K. Light Fixture: Complete light fixture, including ballast housing if provided.

L. RCR: Room cavity ratio.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
2. Marked for intended use.

B. Comply with NFPA 70.

C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

D. Regulatory Agencies: Provide fixtures conforming to nationally- or internationally-recognized accredited testing agencies, such as U.S., ETL, ARL, or others in acceptance with local code enforcement policy.

E. Electrical Components and Devices: Provide only fixtures that comply with National Electric Code (NEC), and in particular to Section 410. All ceiling recessed fixtures, whether indicated in a catalog number or not, shall be equipped with an integral thermal protection device.

F. FMG Compliance: Light fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.6 COORDINATION

A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

B. Coordinate layout and installation of light fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including, but not limited to, HVAC equipment, fire-suppression system, and partition assemblies. Contractor shall arrange his installation in proper relation to other work so that there shall be no interference, damage or delay to other trades' work

C. Give ample notice of any special openings or rough-in work required for placing electrical/lighting work so as to avoid cutting or removal of completed work.

D. Where work of this Section is to be flush or concealed, install it so it does not project beyond finished lines of walls, ceilings or floor surface.

E. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

1.7 WARRANTY

A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.10.A.1. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.

B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.

C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.

1. LED Luminaires, including LED modules, arrays and drivers: Five years.
2. LED Lamps: Three years.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. In Light Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified. No substitutions shall be allowed as per Section 1.4. The approved manufacturers are listed below.

a. Acuity
b. Cooper
c. GE
d. Hubbell

B. National Account Managers for approved manufactures shall be contacted as early as possible to ensure timely shipping of products

1. CED: National Distributor for Hubbell and Acuity Products.

a. Sarah Devlin & Greg Applegate - CEDFC@ced.com

2. City Lighting: National Distributor for Acuity, Cooper, and GE Products.

a. Chris Schmalzried - cschmalzried@citylighting.com

2.2 LIGHT FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Provide light fixtures as shown on the drawings and/or specified. This shall include all lamps, material and labor to securely hang light fixtures, clean them and make them completely ready for use. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures. Provide additional tie wires connected to structure to conform to applicable seismic requirements where required.

B. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.

C. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures. Manufacturer of recessed fixtures shall provide mounting brackets suitable for connection to ceiling system structure. Modifications to standard mounting brackets shall be coordinated with contractor and delivered with fixture so that no delays to product delivery shall be allowed.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. 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.
4. Laminated Silver Metallized Film: 90 percent.

H. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

I. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.

J. Reflectors:

1. Provide aluminum reflectors or reflecting cones for downlight style fixtures comprised of #12 aluminum reflector sheet, 0.57 inch (15 gauge) or heavier and free of tool-making indentations, including spinning lines caused by assembly techniques. All reflectors shall be of first-quality, anodized finish :Alzak” with specular or semi-specular finish and color as selected. Provide specular reflectors with no apparent brightness above 45 degrees from

Nadir and semi-specular, diffuse reflectors with no apparent brightness above 75 degrees from Nadir.

K. Mounting hardware and trims:

1. Coordinate as need to suit ceiling conditions.
2. Light fixtures near or in contact with insulation shall comply with code.
3. Maintain a 3” minimum working clearance between non-IC rated light future housings and insulation on all adjacent ductwork, piping, walls and ceilings.

L. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, and drivers. 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, LEDs, ballast and/or driver characteristics:

a. "USE ONLY" and include specific lamp or LED type.
b. LED type, wattage, beam angle (if applicable) for LED luminaires. Indicate maximum allowed wattage.
c. CCT and CRI for all luminaires.

M. Emergency lights and exit signs with integral battery back-up shall be connected to a separate unswitched conductor bypassing all other controls and contactors. Exit signs shall not be switched. Allow battery to charge for a minimum of 48 hours before light level testing. In order to prevent battery damage, do not turn off power for extended periods of time after the emergency light has been powered.

2.3 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered 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 type with sealed transfer relay.
c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps 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. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

3. Master/Remote Sign Configurations:

    a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
    b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

C. Self-Luminous Signs: Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 10 years.

D. Self-Luminous Signs: Using strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Provide with universal bracket for flush-ceiling, wall, or end mounting.

2.4 DRIVERS FOR LED LUMINAIRES

A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Power Factor: 0.90 or higher at full load.
5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
6. Driver shall operate with maximum sustained variations of +/-10% input voltage and frequency with no damage to driver.
7. Driver output shall be regulated to maximum +/- 5% published load range or requirements of downstream LED fixture.
8. LED Current Crest Factor: 1.5 or less.
9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
10. Meets EN610000 for input harmonics.
11. ROHS Compliant.

B. Dimming Drivers:

1. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:

    a. Luminaires: 100 to 10 percent of rated lumens.
    b. Lamps: 100 to 20 percent of rated lumens.

2. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and LED indicated.
4. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.5 LED LAMPS AND LUMINAIRES

A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 80 CRI minimum and 3500K CCT.

B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values or as indicated in the Light Fixture Schedule, whichever is more stringent. All LEDs used for same fixture type throughout the project to originate from same production bin.

C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% maintained initial-rated lumens at average rated life of as follows:

1. LED lamps: 20,000 hours
2. LED luminaires: 50,0000 hours

D. ROHS compliant

E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Cree, Nichia, Osram or Xicato LEDs; additional manufacturers may be considered however the Architect or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desireable.

2.6 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system. Where equipment is not indicated as plenum rated, provide an additional enclosure for the device(s) suitable for the installed environment.

2.7 LIGHT FIXTURE SUPPORT COMPONENTS

A. Comply with Sections "260548 Seismic Controls for Electrical" and "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 steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Light Fixtures: All work shall be executed to present a neat appearance. Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

C. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

D. Support for Light Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from light fixture corners.
2. Support Clips: Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on light fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Light Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Provide suitable connectors or collars to connect adjoining units to appear as a continuous unit.

F. Unless specifically indicated or approved by the Contract Administrator and Structural Engineer, do not support from roof deck.

G. Connect wiring according to Section "260519 - Low-Voltage Electrical Power Conductors and Cables."

H. Through wiring of recessed light fixtures, in suspended ceilings, is not permitted. Connect each light fixture by a whip to a junction box. The whip shall be of sufficient length to allow the light fixture to be relocated within a 6-foot radius.

I. Wall Mounted Light fixtures

1. Unless otherwise noted, conceal all raceways and back boxes for wall mounted light fixtures. Coordinate all wall-mounted light fixtures with interior elevations. Where specific elevations

or dimensions are not indicated, verify the correct location with Architect prior to installation. Contractor shall supply structure to support weight of fixture.

J. Auxiliary Devices for low voltage and LED Fixtures

1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
2. In public areas or other areas where remote device visibility is undesireable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.
3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
4. Properly support remote lighting devices, including transformers, power supplies, and drivers, per Code and manufacturer's recommendations.

3.3 DIMMING

A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:

1. 0-10V – two low voltage conductors and two line voltage conductors plus ground

B. Coordinate light fixture and control device dimming types for compatibility.

3.4 COORDINATION

A. Light fixtures shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings for exact locations.

B. Coordinate the installation and location of light fixtures with other work and all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.

C. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

D. Wall-Mounted Light fixtures

1. Coordinate all wall-mounted light fixtures with the architectural features of the building. Where specific elevations or dimensions are not indicated, verify the correct location with the Architect prior to beginning any work.

3.5 ADJUSTING

A. Contractor shall adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Architect.

B. At the time of substantial completion, aim all track lights, flood lights, spot lights, and other fixtures requiring aiming per the Architect's direction. Contractor shall make provisions for supplying all scaffolds, lifts, and other tools and equipment as required.

C. Where required, focusing shall be done during hours of darkness. Upon notification by contractor that all fixtures are correct as per shop drawings and functioning, that specified lamps have been verified, lighting designer or Architect shall coordinate with contractor as to a mutually agreed upon time to complete focusing. Failure of contractor to notify Architect during substantial completion will result in failure to comply with specifications.

3.6 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.

C. Upon completion of the installation of light fixtures, and after building circuits have been energized, energize lighting branch circuits to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

D. At the time of final acceptance of this project by the Owner, ensure that all lamps are in working order and all light fixtures are fully lamped.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

F. Photometric Validation Testing: As part of the commissioning process, the General Contractor shall engage a third-party entity to perform a lighting validation survey and provide a report to both the General Contractor and Owner's Construction Manager. This report shall validate lighting levels in all areas inside and outside of the building. The testing equipment shall be performed using a proper light meter (EXtech LT300 or equivalent), to measure the lighting levels. The measured lighting levels shall be recorded on a PDF plan and must be included with the final report.

    a. The programmatic lighting levels are indicated below. All interior lighting levels shall be measured at 36" above finished floor.

        1) Warehouse (general)– 30 FC average
        2) Induct Stations – 30 FC minimum
        3) Material handling areas with Stow-By-Lighting – 20 FC minimum
        4) Material handling areas without Stow-By-Lighting – 30 FC minimum
        5) DSP Manager's Desk – 30 FC minimum
        6) General Office Block Spaces – 30 FC average
        7) Breakroom – 20 FC average
        8) Restrooms – 20 FC average
        9) Cooridors/Stairs – 20 FC minimum
        10) Utility rooms – 20 FC minimum
        11) Locker rooms – 30 FC minimum
        12) Mother's room – 30 FC minimum
        13) Induct Station – 30 FC minimum

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions.

Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

PART 1 - SECTION 265600 - EXTERIOR LIGHTING

PART 2 - GENERAL

2.1 SUMMARY

A. This Section includes the following lighting equipment:

1. Exterior LED light fixtures with LED modules and drivers.
2. Poles and accessories.

2.2 SUBMITTALS

A. General:

1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.
2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.

B. Prepare portfolios from manufacturer's standard specification sheets, and include the number indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.

1. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
2. Modifications to fixtures shall be in accordance with Architect’s comments.

C. Product Data: For each light fixture, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Summary page with the following for each light fixture type

a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
b. Light fixture driver or auxiliary device manufacturer, number and type.

2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.

a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, effective projected area, fixture efficacy and/or efficiency, and verification of indicated parameters.
b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.

3. Light fixture mounting details, including, but not limited to, non-standard outlet boxes.
4. Construction of light fixture housing and door (if applicable).

5. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.

    a. For dimming LED, also include dimming type technology and dimming range/limits.

6. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.

    a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.

7. Details of attaching light fixtures and accessories.
8. Details of installation and construction.
9. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, drivers, and accessories identical to those indicated for the light fixture as applied in this Project.

    a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

10. For pole-mounted LED area lighting fixtures, IES-TM-21 LED luminaire lifetime and lumen maintenance projections.
11. Emergency drivers cut sheet: Descriptive cut sheets providing physical description of emergency drivers for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.
12. Photoelectric relays.
13. Materials, dimensions, and finishes of poles.
14. Means of attaching light fixtures to supports, and indication that attachment is suitable for components involved.
15. Anchor bolts for poles.
16. Manufactured pole foundations.

D. Delegated-Design Submittals for Pole-Mounted Area Lighting: Submit the following documents, signed and sealed by a qualified professional engineer:

1. Structural analysis data and calculations used for pole selection and foundations.

    a. Manufacturer Seismic Qualification Certification: Submit certification that lighting components and their mounting and anchorage provisions are designed to remain in place with out separation of any parts when subject to seismic forces defined in Division 26 Section “Vibration and Seismic and Seismic Controls for Electrical Systems” Include the following:
        1) Basis for Certification: Indicate whether withstand certifications are based on actual test of assembled components or calculation.
        2) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
    b. Manufacturer Wind-Load Strength Certification: Submit certification that selected total support system, including poles and equipment anchorage devices, complies with AASHTO LTS-4 or as required by the local authority having jurisdication, whichever is more stringent, for location of project.

2. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
3. Design calculations for the following:

a. Design calculations indicating strength of screw foundations and soil conditions on which they are based.
b. Design calculations for determination of poured-in-place concrete foundation size and reinforcement

4. Shop Drawings:Submittal Schedule

a. Within 30 days from Division 26 Contractor award, shop drawings covering all light fixtures within this section shall be forwarded to architect to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.
b. Within 15 days of “approved” and “approved as noted” shop drawings, Contractor shall forward to Architect a guaranteed ship date for each specified fixture.
c. Within 15 days after Contractor’s receipt of “reject and resubmit” or “not approved” shop drawings, Contractor shall provide Architect with resubmitted shop drawings for only those fixtures deemed unacceptable.
d. Contractor is responsible to call to the attention of the Architect any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures or as otherwise affecting Section 1.4.D of this specification.

5. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
6. Wiring Diagrams: Power and control wiring.

E. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 or as noted elsewhere in this specification and that loads imposed by light fixtures and attachments have been included in design. This certification shall be based on design calculations by a professional engineer.

F. Qualification Data: For Installer.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For light fixtures to include in operation and maintenance manuals.

I. Warranty: Special warranties specified in this Section.

2.3 DEFINITIONS

A. CCT: Correlated color temperature

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. CV: Coefficient of Variance. The ratio of standard deviation for all illuminance values to the mean illuminance value.

E. Delegated-Design Submittals: Documents, including, but not limited to, drawings, calculations, and material and product specifications prepared as a responsibility of Contractor to obtain acceptance by Owner and authorities having jurisdiction.

F. EISA: Energy Independence and Security Act of 2007.

G. FC: Foot-candles.

H. Horizontial Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches above the ground, unless otherwise indicated.

I. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs

J. LED: Light Emitting Diode

K. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.

L. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.

M. LER: Light fixture efficacy rating.

N. Light fixture: Complete light fixture, including driver housing if provided.

O. LLD: Lamp Lumen Depreciation.

P. LLF: Light Loss Factor.

Q. Luminaire: Complete lighting fixture, including driver housing if provided.

R. Pole: Light fixture support structure, including tower used for large area illumination.

S. Standard: Same definition as "Pole" above.

2.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of light fixture and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in latest AASHTO LTS-4.

B. Live Load: Single load of 500 lbf, distributed as stated in latest AASHTO LTS-4.

C. Ice Load: As stated in latest AASHTO LTS-4 or as required by the local authority having jurisdiction, whichever is more stringent.

D. Wind Load: As stated in latest AASHTO LTS-4 or as required by the local authority having jurisdiction, whichever is more stringent.

2.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer’s authorized representative who is trained and approved for installation of units required for this project.

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 IEEE C2, "National Electrical Safety Code."

D. Comply with NFPA 70.

2.6 COORDINATION

A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

B. Coordinate layout and installation of light fixtures, poles, foundations, and underground raceway system with other above- and below-grade site construction and utilities. Notify Architect/Engineer of conflicts before proceeding with the Work.

2.7 WARRANTY

A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.12.A.1. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.

B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.

C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.

1. LED Luminaires, including LED modules, arrays and drivers: Five years.
2. LED Lamps: Three years.

2.8 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. Retain factory-applied pole wrappings on metal poles until right before pole installation.

D. Handle all poles with web fabric straps.

PART 3 - PRODUCTS AND MATERIALS

3.1 MANUFACTURERS

A. In Light Fixture Schedule (on the drawings) where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified. No substitutions shall be allowed as per Section 1.4. The approved manufacturers are listed below.

    a. Acuity
    b. Cooper
    c. GE
    d. Hubbell

B. National Account Managers for approved manufactures shall be contacted as early as possible to ensure timely shipping of products

1. CED: National Distributor for Hubbell and Acuity Products.

    a. Sarah Devlin & Greg Applegate - CEDFC@ced.com

2. City Lighting: National Distributor for Acuity, Cooper, and GE Products.

    a. Chris Schmalzried - cschmalzried@citylighting.com

3.2 LIGHT FIXTURES, GENERAL REQUIREMENTS

A. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.

B. Light fixtures shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

C. Comply with IES RP-8 for parameters of lateral light distribution patterns indicated for light fixtures.

D. Comply with IES BUG ratings where indicated on the Light Fixture Schedule.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed light fixtures.

H. 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.

I. Exposed Hardware Material: Stainless steel for latches, fasteners, and hinges.

J. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

K. Light Shields: Metal baffles or louvers, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

L. 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.

M. Gaskets for Lenses and Refractors: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in light fixture doors.

N. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.

O. Light Fixture Finish: Manufacturer's standard paint applied to factory-assembled and -tested light fixture before shipping. Where indicated, match finish process and color of pole or support materials.

P. Factory-Applied Finish for Steel Light Fixtures: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As indicated on the Light Fixture Schedule.

Q. Factory-Applied Finish for Aluminum Light Fixtures: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

    a. Color: As indicated on the Light Fixture Schedule.

R. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, and drivers. 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, LEDs, and driver characteristics:

    a. “USES ONLY” and include specific lamp or LED type.

b. LED type, wattage, beam angle (if applicable) for LED luminaires. Include maximum allowed wattage.
c. For LED luminaires, includes CCT and CRI.

3.3 DRIVERS FOR LED LUMINAIRES

A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Power Factor: 0.90 or higher at full load.
5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
6. Driver shall operate with maximum sustained variations of +/- 10% input voltage and frequency with no damage to driver.
7. Driver output shall be regulated to +/- 5% published load range.
8. LED Current Crest Factor: 1.5 or less.
9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
10. Meets EN610000 for input harmonics.
11. ROHS Compliant.
12. Suitable for use in outdoor light fixtures.
13. Dimming Drivers

a. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
3) Luminaires: 100 to 10 percent of rated lumens.
4) LED Lamps: 100 to 20 percent of rated lumens.
b. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
c. Compatibility: Certified by the manufacturer for use with specific dimming control system and LED indicated.
d. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

3.4 LED LAMPS AND LUMINAIRES

A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 70 CRI minimum and 4000K CCT. All LEDs used for same fixture type throughout the project to originate from same production bin.

B. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% of maintained initial-rated lumens at the average rated life as follows:

1. LED outdoor pole mounted area lights: 100,000 hours
2. LED lamps: 20,000 hours
3. Other LED luminaires: 50,0000 hours

C. ROHS compliant

D. Manufacturer of LED chips will be evaluated based on the manufacturer’s product literate and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Nichia, Cree, Xicato or

Osram LEDs; additional manufacturers may be considered however the Architect or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desireable.

3.5 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system.

3.6 LIGHT FIXTURE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.

1. Relay with locking-type receptacle shall comply with NEMA C136.10.
2. Adjustable window slide for adjusting on-off set points.

3.7 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of light fixtures and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Light Fixture Attachment Provisions: Comply with light fixture manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. 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, complying with ASTM A 123/A 123M or ASTM A 153/A 153M unless stainless-steel items are indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, 3000-psi (28-day minimum compressive strength, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, light fixture(s), and accessories.

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

3.8 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Round, tapered.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Light Fixtures: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate light fixture.
3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support light fixture or light fixtures and brackets indicated, and securely fastened to pole top.

E. Vibration Dampeners: Factory furnish for poles over 20’ high.

F. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

G. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "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.

H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

J. Galvanized Finish: After fabrication, hot-dip galvanize complying with ASTM A 123/A 123M.

K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As indicated by manufacturer's designations.

3.9 ALUMINUM POLES

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, Alloy 6063-T6 with access handhole in pole wall.

B. Pole-Top Tenons: Fabricated to support light fixture or light fixtures and brackets indicated, and securely fastened to pole top.

C. Vibration Dampeners: Factory furnish for poles over 20’ high.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "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 Light fixtures: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate light fixture.
2. Finish: Same as pole.

F. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

a. Color: As indicated in the Light Fixture Schedule.

3.10 FIBERGLASS POLES

A. Poles: Comply with ANSI C136.20, with access handhole in pole wall.

1. Mounting: Embedded.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Resin Color: As indicated in the Light Fixture Schedule; provide uniform coloration throughout entire wall thickness.

C. Surface Finish: Pigmented polyurethane, with a minimum dry film thickness of 1.5 mils.

PART 4 - EXECUTION

4.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s instructions.

4.2 EXAMINATION

A. Verify conditions of equipment and installation prior to beginning work.

B. Verify that equipment is ready for connecting, wiring, and energizing.

4.3 LIGHT FIXTURE INSTALLATION

A. Install lamps in each light fixture.

B. Fasten light fixture to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust light fixtures that require field adjustment or aiming.

D. Baffles and Louvers for Spill Light Correction: Install on lighting fixtures with fasteners provided by the manufacturer. Install and adjust to correct out-of-limit spill-light measurements.

E. Auxiliary devices for low voltage and LED fixtures installation

1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
2. In public areas or other areas where remote device visibility is undesireable, install device where concealed from view, well-ventilated and accessible. Provide access panels as required.
3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
4. Properly support remote lighting devices, including, but not limited to, transformers, power supplies, and drivers, per Code and manufacturer's recommendations.
5. Provide enclosures suitable for installation environment as required.

4.4 DIMMING

A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:

1. 0-10V – two low voltage conductors and two line voltage conductors plus ground

B. Coordinate light fixture and control device dimming types for compatibility.

4.5 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of light fixtures and their mounting provisions on the pole. Install poles and other structural units level, plumb, and square.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined 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. Grout materials, installation, and finishing requirements are specified in Division 05 Section “Metal Fabrications”.
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.

E. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Dig holes large enough to permit use of tampers in the full depth of hole.
2. Backfill in 6-inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.

F. Embedded Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.

1. Make holes 6 inches in diameter larger than pole diameter.
2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days, and finish in a dome above finished grade.
3. Use a short piece of 1/2-inch- diameter pipe to make a drain hole through concrete dome. Arrange to drain condensation from interior of pole.
4. Cure concrete a minimum of 72 hours before performing work on pole.

G. 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.

1. Install protective pipe bollards on two sides of each embedded pole installed in paved areas. Refer to Division 05 “Metal Fabrications” for pipe bollards.

H. Raise and set poles using web fabric slings (not chain or cable).

4.6 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LIGHT FIXTURES

A. Install on concrete base with top 4 inches above finished grade or surface at light fixture location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

4.7 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 Division 26 Section "Raceways and Boxes for Electrical Systems", including use of coated conduits in concrete foundations.

4.8 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole, unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting light fixture to grounding system.

B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

4.9 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Architect.

C. Upon completion of the installation of light fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

D. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.

E. At the time of Substantial Completion, aim all adjustable fixtures, such as flood and spot lights, per the Architect’s direction. Provide all necessary equipment to support this effort, such as scaffolds and lifts, as required.

F. At the time of Final Acceptance of this Project by the Owner, all lamps shall be in working order and all light fixtures shall be fully lamped.

G. Illumination Observations: Verify normal operation of lighting units after installing light fixtures and energizing circuits with normal power source.

1. Verify operation of photoelectric controls.

H. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

I. Photometric Validation Testing: As part of the commissioning process, the General Contractor shall engage a third-party entity to perform a lighting validation survey and provide a report to both the General Contractor and Owner’s Construction Manager. This report shall validate lighting levels in all areas inside and outside of the building. The testing equipment shall be performed using a proper light meter (EXtech LT300 or equivalent), to measure the lighting levels. The measured lighting levels shall be recorded on a PDF plan and must be included with the final report.

1. The programmatic lighting levels are indicated below. All exterior lighting levels shall be measured at finished grade.

    a. Site Perimeter – 1.5 FC minimum (20-30’ illumination width) (or per local ordinances)
    b. Parking Lot – 1.5 FC minimum
    c. Dock Areas – 1.5 FC minimum (60’ out from dock doors)
    d. Open Yards – 0.5 FC minimum
    e. Building Exterior – 1.0 FC (5’ from the building face)
    f. Building Access Doors – 10 FC minimum (10’ out from door)
    g. Pedestrian Walkway – 3.0 FC minimum
    h. Launchpad Canopy – 10 FC minimum

4.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain light fixtures. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 265600

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SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain link fence and gates.

2. Black privacy slats

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by the basic designation only.

B. ASTM International (ASTM):

1. ASTM A 392 - Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

C. Chain Link Fence Manufacturers Institute (CLFMI): Product Manual.

1.3 QUALITY ASSURANCE

A. Chain link fabric, posts, and components, and installation shall conform with the requirements of the CLFMI Product Manual unless otherwise shown or specified.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum 3 years documented experience.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Posts: Type I or II or roll formed "C" Section steel conforming to CLFMI and as specified hereinafter.

B. Fabric:

1. No. 9 gage galvanized steel wire in 2 inch mesh; ASTM A 392, height as shown.
2. Fabric height less than 72 inches: Top and bottom selvages knuckled.
3. Fabric height 72 inches and greater: Top selvage twisted; bottom selvage knuckled.

C. Black privacy slats to extend full height of fencing

2.2 COMPONENTS

A. End, Corner, and Pull Posts: Minimum sizes and weights as follows unless otherwise shown.

1. Up to 13 Foot Fabric Height: Type I or II in accordance with CLFMI Product Manual.
2. 13 foot and over Fabric Height:

a. Type I Posts: Round; 4.0 inch outside diameter pipe, 9.10 lbs/lin ft.
b. Type II Posts: 4.0 inch outside diameter pipe, 6.56 lbs/lin ft.

B. Line (Intermediate) Posts: Minimum sizes and weights as follows unless otherwise shown.

1. Up to 8 Foot Fabric Height: Type I, II, or "C" Section in accordance with CLFMI Product Manual.
2. Over 8 Foot Fabric Height:

a. Type I Posts:

1) Round: 2.875 inch outside diameter pipe, 5.79 lbs/lin ft.
2) Square: 2.5" x 2.5" outside dimension, 5.10 lbs/lin ft.

b. Type II Posts: 2.875 inch outside diameter pipe, 4.64 lbs/lin ft.

C. Gate Posts: Type I or II in accordance with CLFMI Product Manual unless otherwise shown.

D. Top, Bottom, and Intermediate Rails: Manufacturer's longest lengths.

1. Type I or II in accordance with CLFMI Product Manual.
2. Couplings: Expansion type, approximately 6 inches long.
3. Attaching Devices: Means of attaching top rail securely to each gate, corner, pull, and end post.
4. Do not install bottom rail at truck well fence which shall receive tension wire instead.

2.3 ACCESSORIES

A. Sleeves: Galvanized steel pipe with inside diameter not less than 1/2 inch greater than outside diameter of fence posts. Provide steel plate closure welded to bottom of sleeves of width and length not less than 1 inch greater than outside diameter of sleeve.

1. Up to 6 Foot Fabric Height: Provide sleeve not less than 12 inches long.
2. Over 6 Foot Fabric Height (Not for Partitions Tight to Roof Deck): Provide sleeve not less than 24 inches long.
3. Fabric Installed Tight to Roof Deck (Posts Braced to Roof Structure): Provide sleeve not less than 12 inches long.

B. Tension Wire: 7 gage steel, metallic-coated coil spring wire, located at bottom of fence fabric.

C. Wire Ties: 11 gage galvanized steel.

D. Post Brace Assembly: Manufacturer's standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same materials as top rail for brace, and truss to line posts with 0.375 inch diameter rod and adjustable tightener.

E. Post Tops: Galvanized steel, weather tight closure cap for tubular posts, one cap for each post. Furnish cap with openings to permit passage of top rail as required.

F. Stretcher Bars: Galvanized steel, one piece lengths equal to full height of fabric; with minimum cross section of 3/16 x 3/4 inch. Provide one stretcher bar for each gate and end post, and two for each corner and pull post.

G. Stretcher Bar Bands: Manufacturer's standard.

H. Gate Cross-Bracing: 3/8 inch diameter galvanized steel adjustable length truss rods.

I. Gate Hardware:

1. Swinging Gate Hardware:

a. Hinges:

1) Size and material to suit gate size; offset to permit 180 degree gate opening. Provide 1-1/2 pair of hinges for each leaf over 6'-0" nominal height.
2) Provide all gate hardware including latches, panic hardware with associated mounts and card readers at locations indicated in the Drawings.

b. Latch:

1) Interior: Provide a deadbolt E2141 function (key operate both side) with a 7-pin SFIC lock set.

2. Fencing shall typically be positioned a minimum of 2 feet (0.61m) from back of curb or back of sidewalk, or 3 feet (0.91m) minimum within the Truck Court (additional setback criteria applies behind trailer parking).

3. Exterior yard perimeter security fencing around the Truck Court shall be 8-foot (2.44m)-high galvanized chain link fence. Provide 3 strands of barbed wire (above 8-foot (2.44m) fence) as allowed by Local Jurisdiction. Changes required by Local Jurisdiction must be reviewed with the Tenant. Locate fencing minimum 15 feet (4.57m) behind trailer parking curb. Light poles, fire hydrants, and other site accessories should be located within the perimeter fence line and a minimum 12 feet (3.66m) from back of trailer parking curb to face of object. Where site restrictions prevent the desired setback, provide highway guide rail or bollards to prevent damage to fencing and/or light poles.

4. For the vehicular entry gate into the Truck Court, provide gate stops set in concrete designed to engage a drop rod for swing gates when in the open and closed position 90-degree minimum. Provide locking hardware for padlock.

5. Local fire code may require the installation of separate vehicle gate to facilitate access for emergency vehicles. These gates should be constructed out of the same material as the fence itself and be locked according to local codes. These gates may not be used for routine access and shall be equipped with a door position switch reporting on an open condition to the security system. A horn and strobe shall be provided adjacent to the gate and shall be configured to alarm if the gate is open.

6. For the pedestrian entry gate, provide locking hardware for padlock.

7. A 5-foot (1.52m) high black PVC-coated 9-gauge 2-inch (50.8mm) mesh chain link pedestrian barrier fence shall be provided from the van parking lot to the building to control the pedestrian route and prevent inadvertent foot traffic across major drive lanes and within the van queuing and loading area.

J. Anchors for Surface-Mounted Posts: As shown on Drawings.

2.4 SETTING MIXES

A. Concrete: Reference Section 033000.

B. Grout: Premixed, factory-packaged, non-staining, non-corrosive grout. Reference Section 033000. Provide type specially formulated for exterior application.

2.5 GATE FABRICATION

A. Fabricate gate frames of min. 1.90 inch outside diameter galvanized steel pipe. Provide horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware, and accessories. Space frame members maximum 8'-0" apart.

B. Assemble gate frames rigidly by welding or with special fittings and rivets. Use same fabric as specified for fence. Install fabric with stretcher bars at vertical edges. Bars may also be used at top and bottom edges. Attach stretchers to frame at not more than 15 inches on center. Install diagonal cross-bracing on gates as required to ensure frame rigidity without sag or twist.

C. Attach fabric on sliding gates to maintain bottom clearance as specified below in Installation.

D. Attach hardware to provide security against removal or breakage.

2.6 FINISH

A. Fabric and Framing: Zinc coated in accordance with CLFMI Product Manual.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install chain link fence in accordance with CLFMI Product Manual unless otherwise specified herein.

B. Space line posts 10'-0" on center maximum, except as otherwise indicated.

1. Space line posts at 8'-0" on center maximum if plastic slats are indicated to be installed in fence fabric.
2. Space interior line posts 8'-0" on center maximum.

C. Methods for Setting Posts:

1. Grade-Set Posts:

   a. Drill or hand excavate to a depth approximately 3 inches lower than post bottom. Set post bottom at depth indicated on Drawings.
   b. Excavate each post hole to 12 inch diameter, or not less than four times diameter of post.
   c. Hold post in position while placing, consolidating, and finishing concrete.
   d. Post shall be set plumb within 1/4" in 10 feet.

2. Sleeve-Set Posts In Slabs: Anchor posts in concrete by means of pipe sleeves preset into concrete to depth not less than 24 inches below finish slab, and anchored into concrete. Insert posts into sleeves and fill annular space between post and sleeve solid with grout. Mix and place grout in accordance with manufacturer's published instructions.

3. Surface-Mounted Posts: Anchor plates to concrete slab as shown on Drawings. Comply with Section 05090 for anchor installation.

D. Intermediate Rails: Provide center and bottom rails where indicated. Install in one piece between posts and flush with post on fabric side, using offset fittings where necessary. Place intermediate rails a maximum of 6 feet on center.

E. Brace Assemblies: Install braces so posts are plumb with rod in tension.

F. Tension Wire: Install tension wires through post cap loops before stretching fabric and tie to each post cap with not less than 6 gage galvanized wire. Fasten fabric to tension wire using 11 gage galvanized steel hog rings spaced 24 inches on center.

G. Fabric: Space between bottom of fabric and finish grade shall be not greater than 2 inches. Space between bottom of fabric and finish grade shall not be greater the 1/2-inch on sliding gates. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so fabric remains in tension after pulling force is released.

H. Stretcher Bars: To secure end, corner, pull, and gate posts, thread through or clamp to fabric 4 inches on center and secure to posts with metal bands spaced 15 inches on center.

I. Tie Wires:

1. Use U-shaped wire conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted two full turns. Bend wire ends to minimize hazards to persons or clothing.
2. Tie fabric to line posts with wire ties spaced 12 inches on center. Tie fabric to rails and braces with wire ties spaced 24 inches on center. Manufacturer's standard procedure will be accepted if of equal strength and durability.

J. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

K. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.2 ERECTION TOLERANCES

A. Maximum Variation from Plumb: 1/4 inch.

B. Maximum Offset from True Position: 1 inch.

END OF SECTION 323113

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SECTION 323300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Section includes bicycle racks.

1.2 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 BICYCLE RACKS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Madrax; a division of Graber Manufacturing, Inc. 1080 Uniek Drive, Waunakee, WI 53597. Toll free phone: 800-448-7931. Local phone: 608-849-1080.

B. Bicycle Rack Construction:

1. Frame: Rack shall be constructed of 2 3/8” (60.4mm) diameter carbon steel tubing.
2. Style: HW238-3.
3. Accessories: Base covers for each pipe and tubing anchored end.
4. Installation Method: Surface flange anchored at finished grade to substrate indicated.

2.2 MATERIALS

A. Powder Coating: Triglycidyl Isocyanurate (TGIC) powder, a polyester coating. Coating is applied so that the thickness is 3.5 to 4.5 mils:

1. Color – As Selected by Architect from Manufacturer’s full range of colors.

B. Stainless Steel: Free of surface blemishes and complying with the following:

1. Pipe: Schedule 40 steel pipe complying with ASTM A312/A312M.

C. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality.

D. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M; recommended in writing by manufacturer, for exterior applications.

2.3 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections,

finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

E. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

D. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 323300